

REVIEWED: AMD's Radeon R9 Fury, the 4K powerhouse

PCWorld

AUGUST 2015



WINDOWS 10: HOW TO UPGRADE

ScanSnap



Business ready

ix100 wireless mobile scanner

Incredibly fast

Lithium-powered

Lightweight



<http://ez.com/pcwo>



© 2015 Fujitsu Computer Products of America, Inc. All rights reserved. Fujitsu and the Fujitsu logo are registered trademarks of Fujitsu Ltd. All other trademarks are the property of their respective owners.

» DEPARTMENTS



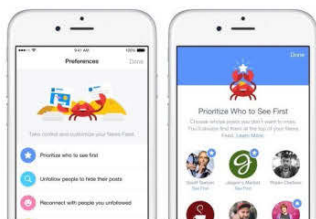
7 News



57 Reviews & Ratings

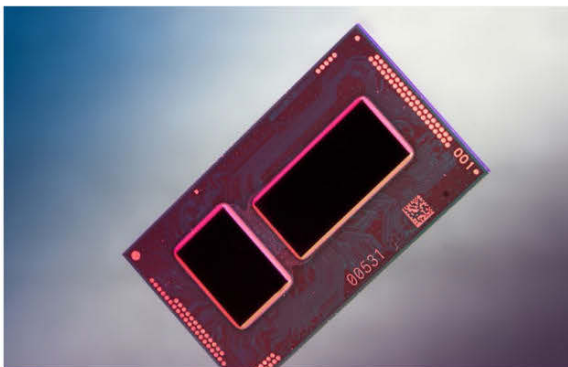


143 Here's How



40 Consumer Watch

» FEATURES



124 The truth about Intel's Broadwell vs. Haswell CPU



134 5 free Wi-Fi tools to help maximize your home network



165 Tech Spotlight

» COLUMNS

160 Hassle-Free PC

162 Answer Line



Tap icons for
other ways to
read PCWorld.

PCWorld



Follow
Jon's tweets.

CCO & SVP, U.S. MEDIA AT IDG John Gallant

EDITOR IN CHIEF, CONSUMER BRANDS Jon Phillips

DESIGN DIRECTOR Rob Schultz

EDITORIAL

EXECUTIVE EDITORS Melissa Riofrio, Gordon Mah Ung

SENIOR EDITORS Michael Brown, Brad Chacos, Mark Hachman

ASSOCIATE EDITOR Caitlin McGarry

STAFF WRITER Florence Ion

COPY EDITOR Sue Voelkel

DESIGN

DESIGNER Monica Lee

ADVERTISING SALES

SALES MANAGER Duane Hampson (415/978-3133)

PRODUCTION

DIRECTOR, PRODUCTION Nancy Jonathans

SENIOR PRODUCTION MANAGER Tamara Gargus

FOUNDERS

FOUNDER David Bunnell

FOUNDING EDITOR Andrew Fluegelman

INTERNATIONAL DATA GROUP, INC.

CHAIRMAN OF THE BOARD Walter Boyd

CEO, IDG COMMUNICATIONS Michael Friedenberg

REPRINTS AND PERMISSIONS

You must have permission before reproducing any material from *PCWorld*. Send email requests to permissions@pcworld.com; please include a phone number in your message.

BACK ISSUES

PCWorld back issues can be downloaded in digital format from www.zinio.com at \$6.99 per issue. Back issues in print format (subject to availability) cost \$8 per issue for U.S. delivery, and \$12 for international delivery; prepayment in U.S. currency to *PCWorld* is required. Send a check or money order to *PCWorld* Back Issues, P.O. Box 37881, Boone, IA 50037-0781.

SUBSCRIPTION SERVICES

Access your subscription account online—24 hours a day, 7 days a week. You can use online subscription services to view your account status, change your address, pay your bill, renew your subscription, get the answers to frequently asked questions, and more.

WEB pcworld.com/support

EMAIL maghelp@pcworld.com

(Send your full name and the address at which you subscribe; do not send attachments.)

PHONE In the U.S. and Canada: 800/234-3498

QUESTIONS AND COLUMNS

Send material electronically to the appropriate online address listed below, or mail it to *PCWorld*. We reserve the right to edit letters.

ANSWER LINE answer@pcworld.com

MAILING LISTS

Occasionally we make our magazine subscribers' names available to other firms whose products may interest you. To have your name excluded from these mailings, send a request and your email address to PCWorld Subscriber Services at maghelp@pcworld.com.

CONTACT

PHONE 415/243-0500; **FAX** 415/442-1891

MAIL Editorial: 501 Second Street #600, San Francisco, CA 94107

STAFF ADDRESS To contact any *PCWorld* staff member, simply format the address as follows: firstinitiallastname@idgcsmb.com

PUBLICATION INFORMATION

Volume 33, number 08 *PCWorld*™ (ISSN 0737-8939) is published monthly at \$24.95 for one year (12 issues) by IDG Consumer & SMB, Inc. Copyright 2015, IDG Consumer & SMB, Inc. All rights reserved. *PC World* and Consumer Watch are registered trademarks of International Data Group, Inc., and used under license by IDG Consumer & SMB, Inc. Published in the United States.



Think It Up™

**STUDENT POWERED.
TEACHER LED.
CROWD FUNDED.™**

Think It Up is a new movement created to inspire students to pursue their passions through student-powered, teacher-led learning projects in classrooms across the country with support from Staples for Students.

Students and teachers: How can you spark great learning experiences in your classrooms today?

Think It Up - because the work that students and teachers accomplish today will change our world tomorrow.

Join us at
thinkitup.org
staplesforstudents.org



Think It Up™
STUDENT POWERED. TEACHER LED. CROWD FUNDED.™



Powered by  **DonorsChoose.org**

Nick Jonas,
Think It Up Ambassador

NEWS

CONTENTS

- 8 **How to upgrade to Windows 10: What you need to know**
- 14 **For Microsoft, the only way out of its big Windows Phone mess is to follow Apple**
- 20 **Surface, Windows RT tablets receiving promised update soon (but not Windows 10)**
- 22 **IBM's crazy-thin 7nm chip will hold 20 billion transistors**
- 26 **BBC reveals Micro:bit, a programmable PC that fits in your pocket**
- 30 **AMD Catalyst 15.7 drivers add pretty much every feature Radeon gamers begged for**
- 36 **Giant mechs from Japan, U.S. will meet in epic robot battle**



How to upgrade to Windows 10: What you need to know

Now that we know when and how Microsoft plans to upgrade consumers to Windows 10, in detail, we can pass that advice along to you. Here's our guide to making the big move.

BY MARK HACHMAN

Beginning July 29, Windows 7 and Windows 8.1 users will be able to download Windows 10. It's a monumental shift for both Microsoft and its customers. But Microsoft has provided a wealth of information to ease the transition, and let you upgrade to Windows 10 as simply and easily as possible.

For consumers, the choice is a simple one: You'll be upgraded to one of two versions of Windows 10: Windows 10 Home, or Windows 10 Professional. (This guide doesn't cover the upgrade process to Windows 10 Mobile for phones.) Microsoft has also released the official retail pricing for Windows 10 (go.pcworld.com/win10cost), in case you're building your own PC.

During the update process, plan to invest some time in prep work and at least an hour in the upgrade process itself. And be careful—some of your applications may be left behind.

Aside from one major component of some versions of Windows 7, however, the transition between the earlier versions of Microsoft's operating system and the new Windows 10 should be relatively painless. Basically, if you own a Pro version of Windows, you'll migrate to the Professional version of Windows 10. Otherwise, expect to receive a copy of Windows 10 Home.

The upgrade
path from
Windows 7
and 8.1 to
Windows 10.

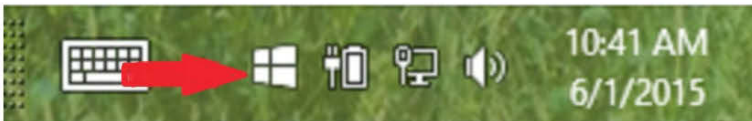
Windows 7*		Windows 8**	
From Edition	To Edition	From Edition	To Edition
Windows 7 Starter	Windows 10 Ultimate	Windows Phone 8.1****	Windows 10 Mobile
Windows 7 Home Basic		Windows 8.1***	Windows 10 Home
Windows 7 Home Premium		Windows 8.1 Pro	Windows 10 Pro
Windows 7 Professional	Windows 10 Pro	Windows 8.1 Pro for Students	
Windows 7 Ultimate			

Besides this story, a good reference is Microsoft's Windows 10 FAQ itself (go.pcworld.com/win10FAQ), which explains, for example, what the Windows 10 reservation app is, how it works, whether you can update more than one Windows PC (yes) and whether you can cancel

your reservation (also yes). Also, it offers one piece of important advice: You must be running a genuine, licensed copy of Windows.

Windows 10 prep work

If there's one thing you need to make sure of, though, it's that your PC is up to date. Windows 7 users must be running Service Pack 1 to enable the update, and Windows 8 users must have upgraded to the latest version of Windows 8.1. You'll also need to enable your Windows 10 reservation. Look for the tiny Windows icon down in the right corner of your taskbar, and click it to launch the Windows 10 reservation app. (We walk you through the reservation process at: go.pcworld.com/win10res.)



Here are the system requirements for Windows 10:

Processor: 1 gigahertz (GHz) or faster processor or SoC

RAM: 1 gigabyte (GB) for a 32-bit version, or 2GB for 64-bit

Hard-disk space: 16GB for a 32-bit OS; 20GB for 64-bit OS

Graphics card: DirectX 9 or later with WDDM 1.0 driver

Display: 1024 x 600

Microsoft also warns that even if your PC seemingly meets those specifications, it might not be upgraded. “Driver and firmware support, application compatibility, and feature support” could affect whether the Windows 10 upgrade takes place. Fortunately, there's one way to be sure: use the “check my PC” function within the reservation app.

Microsoft advises that the Windows 10 download will be about 3GB in size. Installation will take about 20 minutes for newer PCs, and possibly more than an hour for older ones. What the reservation process does is kick off background loading of some files before Windows 10 “unlocks” on July 29. (Some preordered PC games do the

same thing.)

Be smart: Make sure all of your important files are backed up before beginning the upgrade process, either via OneDrive or a local external hard drive. By default, your files will remain on the hard drive. “Applications, files and settings will migrate as part of the upgrade, however some applications or settings may not migrate,” Microsoft says, somewhat cryptically.

And yes, it’s completely free, as long as you take advantage of the upgrade before July 29, 2016. Microsoft promises that upgrades will be free for the “supported lifespan” of the device; that’s the phrase that the company hasn’t really explained fully as yet.

Take advantage of cloud storage to save critical apps and files.

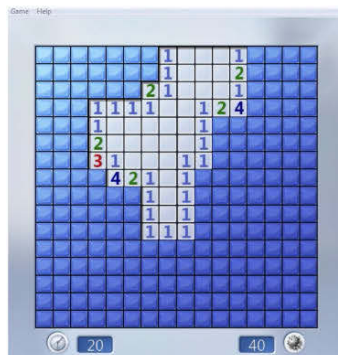
What you’ll leave behind by migrating to Windows 10

The upgrade process will involve some sacrifices—but Microsoft is making an effort to make the transition as painless as possible.

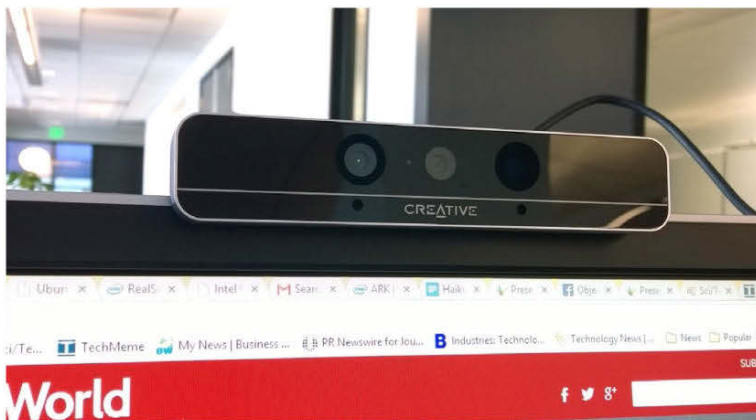
For one thing, if you own the premium versions of Windows 7—Windows 7 Home Premium, Windows 7 Professional, Windows 7 Ultimate—as well as Windows 8 Pro with Media Center or Windows 8.1 Pro with Media Center...say goodbye to Media Center. Microsoft is going to install its own DVD-playing app into Windows 10 to replace it. Likewise, Windows 7 desktop gadgets will be uninstalled. And the Windows 7 versions of Solitaire, Minesweeper, and Hearts that came with Windows 7 will also vanish, to be replaced with new versions of those apps with Windows 10.

Microsoft also says that it may erase “some applications that came from your OEM.” That seems to imply that some of your PC’s bloatware—or prized utilities, depending on your view—could vanish.

Finally, Microsoft will uninstall, then reinstall, your antivirus application. If your subscription is out of date, however, only



Your beloved Minesweeper will be revamped for Windows 10.



Windows Hello won't recognize your face without a specialized depth camera.

Microsoft's own subpar antivirus app, Windows Defender, will be installed. Be sure and check this after upgrading.

Some additional assembly required

Keep in mind that older hardware simply won't include some of the hardware conveniences being included inside new Windows 10 machines. For example, Windows Hello (go.pcworld.com/w10hello), which logs you in to your PC by recognizing your face or your fingerprint, won't work with a webcam—you'll need a new depth camera (like a Kinect for Windows or Intel's RealSense) to enable it, or a fingerprint reader. Speech recognition will work best with a high-fidelity microphone array, no surprise there. And there's a whole host of nitty-gritty specifics that Microsoft has included for Windows 10 Professional, such as a requirement for BitLocker and Wi-Fi Direct Printing.

In general, however, it seems like your pre-Windows 10 checklist will be pretty short: Sign up for a "reservation" for Windows 10, back up critical files, and keep an eye on your antivirus subscription as the transition takes place. Chances are we'll be upgrading at the same time, so you can rest assured that we're all in it together. 🔌

NOVELS ROCK 'N' ROLL
STAND-UP COMEDY JAZZ
VIDEO GAMES MOVIES
COMIC BOOKS TALK RADIO

EVERY NEW ART FORM HAS ITS FIGHT FOR FREE SPEECH.

OUR TIME IS NOW
FIGHT FOR YOUR VIDEO GAMES



V I D E O G A M E V O T E R S . O R G

For Microsoft, the only way out of its big Windows Phone mess is to follow Apple

BY MARK HACHMAN

A FEW WELL-REGARDED flagship devices, a focused core experience, a vibrant app ecosystem, and a belief in the quality of its own products: Apple lives and breathes these things, and has achieved massive profitability in the phone space as a result. And it's about the only strategy Microsoft has left to try.

Soon after purchasing Nokia's device business for \$7.2 billion last year, Microsoft began to dismantle it—first laying off a third of the staff, and more recently waving goodbye to business unit head Stephen Elop and other top executives. Now it's writing off (go.pcworld.com/writeoff) another \$7.6 billion in impairment from the Nokia Devices and Services Business and laying off 7,800 employees. These actions tacitly acknowledge two errors: First, buying Nokia itself was a colossal mistake. Second, the strategy of making mass-market boring phones instead of eye-catching flagship phones was failing.





Sure, they were gigantic. But no one has forgotten the Lumia 1520 flagship phablet.

But ignore all the enormous numbers flying around, and focus on what's important. The \$7.2 billion Microsoft paid for Nokia is the same amount the company doled out to shareholders just last quarter, in both share repurchases and dividends. Wall Street might be livid, but Microsoft's still got plenty left in the war chest.

The real question is whether Microsoft's Windows Phone strategy is still viable. And the answer is: yes—although Microsoft is now essentially betting the farm on a successful launch of Windows 10 Mobile this fall. Nadella pledged to bring to market a more “effective” portfolio of Windows phones, a strategy of tough love that managed to be both practical as well as aspirational.

“We plan to narrow our focus to three customer segments where we can make unique contributions and where we can differentiate through the combination of our hardware and software,” Nadella wrote in an email (go.pcworld.com/nadella) that the company published. “We’ll bring business customers the best management, security and productivity experiences they need; value phone buyers

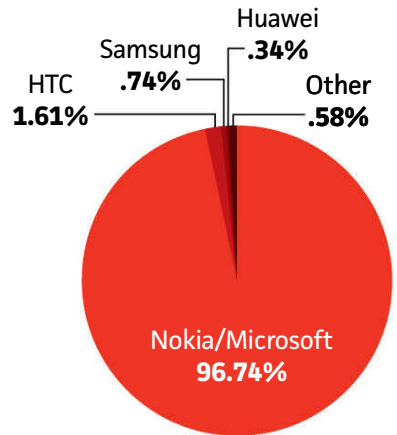
the communications services they want; and Windows fans the flagship devices they'll love."

A solid business experience, flagship devices, and budget phones. Well, two out of three ain't bad.

Going it alone

It's not entirely clear what Nadella's long-term strategy is. Optimists will note that Nadella explicitly states that he is "committed to our first-party devices including phones." Pessimists, like analyst Jan Dawson (go.pcworld.com/dawson), believe that Microsoft's strategy of pushing core services like Outlook, OneDrive, and more to iOS and Android is a hedge that gives Microsoft a graceful way to exit from the phone business if need be.

If Microsoft is going to make a go of the Windows Phone business, it will have to go it alone. In June, AdDuplex's sample of Windows Phones found that more than 96 percent of them were manufactured by Microsoft.



Windows Phone
8 manufacturers, according to the latest AdDuplex numbers.



Microsoft doesn't need dozens of budget phones, just older flagships that it can sell at a discount.

“I honestly expected some of this, and it is likely, economically, a tough, but necessary choice,” Wes Miller, an analyst with Directions on Microsoft, said in an email. “It seems that there hasn’t been a cohesive strategy for Lumia Windows Phones to date in terms of branding, marquee devices, or device evolution.”

Miller said he sees Lumia’s evolution unfolding like this: Microsoft will try to sell business customers on Office 365 and its Enterprise Mobility Suite, while Microsoft will abandon the low end of the market and focus on premium devices. Microsoft will then encourage budget consumers to adopt Skype, Outlook.com, and OneDrive on other devices to lure them into the Microsoft ecosystem.

The Apple model: Do it right, do it yourself

Ideally, Microsoft’s own first-party Lumia phones would stand as a Surface of sorts for the phone market. Nadella has been remarkably consistent with its message: He wants Microsoft to create new categories of devices that others can learn from, emulate, and follow into the market. Today, we’re seeing a number of well-built two-in-one PCs or ultrabooks that are just a bit more rugged than the Surface Pro 3.

Ideally, Microsoft’s own first-party Lumia phones would stand as a Surface of sorts for the phone market.

But Microsoft’s Surface model also assumes two conditions that the Windows Phone market lacks: a coterie of hardware makers trained to follow Microsoft’s lead, and a healthy app ecosystem. Microsoft hoped to solve the first problem by seeding budget phones in the U.S. and abroad, boosting sales and helping to make the case that a viable market existed. Its more recent plan (go.pcworld.com/msplan) to bring iOS and Android apps to the Windows platform was designed to convince software developers that they could make money from Windows, too.

Hopefully, Nadella’s memo shows that its budget phone strategy was a mistake. Apple devotees can certainly tell you what components

Apple built into the iPhone 6, but even the most ardent Windows Phone fanboy would be hard-pressed to differentiate one Lumia budget phone from another.

Apple has shown us that a phone maker doesn't need dozens of unremarkable budget phones. Instead, it marks down the price of yesterday's flagship. Neither does it depend upon a number of hardware partners eager to flood the market with their own knockoffs.

Another case for the Surface phone

I would argue that the core experience of a Windows Phone is as vibrant as anything Apple makes. But Microsoft needs to develop a flagship phone that can embody it. So far, something like the Surface phone has been merely a concept (go.pcworld.com/concept)—but maybe it truly needs to become a reality.

This fall, Microsoft needs to proudly unveil Windows 10 Mobile and show that its new operating system creates the best business phone on the market today. It needs to show how the new universal Office apps let users edit and even create documents on the road. And if, just if, they lose everything except their Windows phone, they can replace their Windows PC with a Windows 10 phone running Continuum. Those Windows 10 phones should be well-designed,

It's a phone! It's a PC! Continuum offers something else no other phone does, and Microsoft needs to sell this feature in a big way.





This fake Microsoft

Surface phone, created by Nadir Aslam, is the flagship smartphone we want.

desirable devices that will attract new customers and deepen the ties with Windows faithfuls.

Microsoft has said it will ship new flagship phones in the fall. Assuming that work is nearly completed, today's layoffs could be something more akin to game developers' being let go at the completion of a project. Microsoft's phone business should keep moving forward powered by its own momentum.

The real test will come this fall, when customers evaluate the new flagship phones, Windows 10 Mobile, and Microsoft's new strategy for its Lumia line. Only then will Nadella and the rest of his team grade Microsoft's phone business, and determine whether it will pass, or fail. 🔌

Surface, Windows RT tablets receiving promised update soon (but not Windows 10)

BY JARED NEWMAN

USERS OF MICROSOFT'S original Surface and other Windows RT devices won't have to wait much longer to get some features of Windows 10.

As *WinBeta* (go.pcworld.com/winbeta) notes, Microsoft has updated its Windows 10 FAQ (go.pcworld.com/win10FAQ) with a short line about what Windows RT users can expect. "If you're running Windows RT, your device won't upgrade to Windows 10, but we will have an update for you around the time of Windows 10 release," the FAQ says. (Note: Microsoft's popular Surface Pro line runs the full-blown version of Windows and will receive Windows 10.)

Windows RT was Microsoft's ill-conceived effort to run Windows on ARM, the architecture that powers most smartphones and tablets. Although Windows RT looked similar to Windows 8, it couldn't run desktop software with the exception of Microsoft's built-in apps and Office suite. The




benefits of Windows RT were minimal, as Intel quickly closed the battery efficiency gap with its lightweight Atom processors, and the drawbacks of limited functionality and customer confusion were significant. PC vendors quickly abandoned ship on the whole concept.

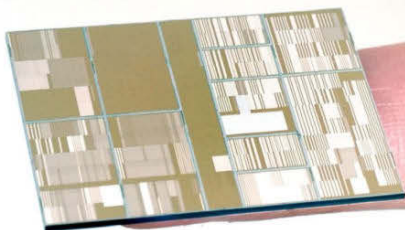
With Windows 10, Microsoft is changing course. The only ARM-based Windows 10 devices will be descendants of Windows Phone, with screens 7 inches or smaller, and these

devices won't have a desktop mode. Larger devices will run full Windows 10 on x86-based processors, but will offer universal apps that run across all screen sizes.

In January, Microsoft said Windows RT devices will get some Windows 10 features in a future update, but the company hadn't revealed timing until now.

The impact on you at home: The update to Microsoft's FAQ should provide some comfort to those who believed in Windows RT, though it doesn't give any sense of what features they'll actually get. Windows 10's big ticket features include the Cortana virtual assistant, the new Edge browser, a pop-up desktop Start menu, and a "Continuum" feature that seamlessly switches between full-screen and windowed apps. Any bets on which of those features land in the updated Windows RT? 

With Windows 10, Microsoft is changing course. The only ARM-based Windows 10 devices will be descendants of Windows Phone.



IBM's crazy-thin 7nm chip will hold 20 billion transistors

BY BRAD CHACOS

HOW FAR CAN we push Moore's Law (go.pcworld.com/moore)? It's starting to become a concerning question as processors push into almost infinitesimally small process nodes.

Intel's 14-nanometer Broadwell chips suffered from lengthy delays, stuttering Intel's vaunted tick-tock manufacturing schedule. TSMC, the company that manufactures graphics processors for AMD and Nvidia, has been stuck at the 28nm node for years now. Intel plans to push into 10nm in 2017, but IBM's looking beyond that, and just revealed the world's first working 7nm processor—but it took some pretty exotic manufacturing to get there.

Creating a working 7nm chip required moving past pure silicon, IBM revealed (go.pcworld.com/ibm). IBM—working with GlobalFoundries, Samsung, SUNY Polytechnic Institute, and others—carved the

transistor channels out of silicon-germanium (SiGe) alloy in order to improve electron mobility at such a small scale. Intel has also said 10nm will be last gasp for pure silicon chips.

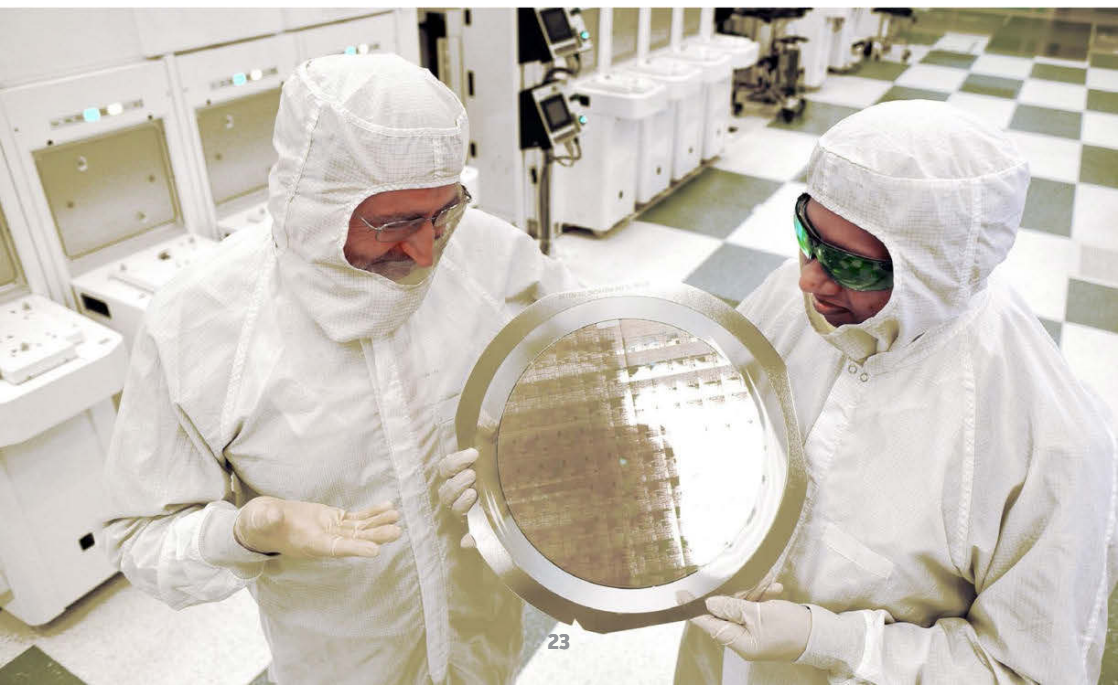
IBM and Co. had to turn to cutting-edge lithography techniques to etch features onto the chip. The companies utilized extreme ultraviolet lithography, which Intel has also been investing heavily in for years now. The details behind EUV get complicated, but essentially, it's a beam of light with a far narrower wavelength (read: width) than current lithography tools. The benefits of moving to a smaller feature-etching tool when working on a chip with 7nm components is obvious.

The consortium also managed to stack the chip incredibly tightly, with a 30nm transistor pitch, which helped it achieve a nearly 50 percent surface area reduction over today's top-end chips.

The 7nm SiGe chips are nowhere near production-ready, but when they're cleared for commercial use around 2017, IBM says they'll result in "at least a 50 percent power/performance improvement for next

SUNY's Michael Liehr, left, and IBM's Bala Haranand look at a wafer of 7nm chips

DARRYL BAUTISTA/IBM



generation...systems” on account of all those process improvements. *Ars Technica* (go.pcworld.com/arstech) has a wonderfully detailed write-up on the manufacturing process for IBM’s 7nm chips.

But that’s not even the most impressive number. IBM says that when the industry embraces 7nm manufacturing techniques, processors will be able to be stuffed with an incredible 20 billion transistors. By comparison, Intel’s new Broadwell-U processors pack “only” 1.9 billion transistors. 🔌

You might know **Joshua**.
He loves video games, and he
owns enough to know they're not
all meant for kids. That's why he
reminds his friends (at least the
ones that have kids) that they all
have **big black letters on the box**
to help parents find the ones that
are best for their families.

You can learn about those
ratings at **ESRB.org**

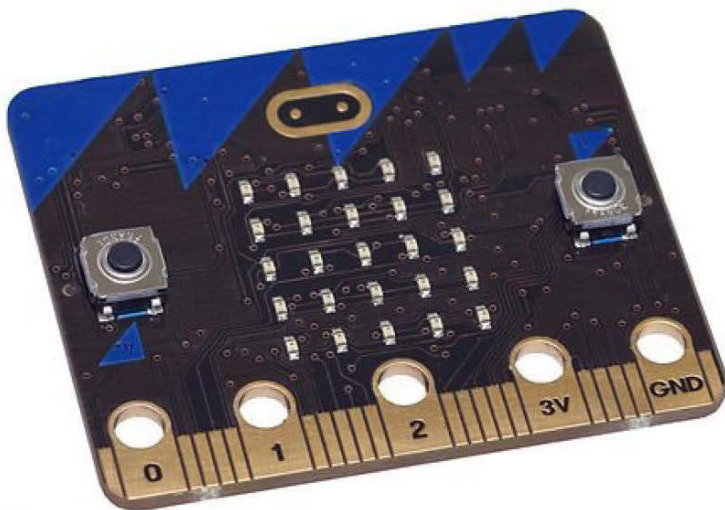


Los Angeles, CA



ENTERTAINMENT SOFTWARE
RATING BOARD





BBC reveals Micro:bit, a programmable PC that fits in your pocket

BY IAN PAUL

THE BBC IS getting into the hardware hacking craze with its second device in the last 34 years for school-age children. The British broadcaster recently unveiled the Micro:bit, a mini-programmable computer meant to teach children how to code and develop hardware projects.

The device will be given away to every child in Year 7 at schools in the United Kingdom—around one million students—beginning in

The Micro:bit requires an add-on battery pack to work as a standalone device



October. Before the end of the year, the device will also be available for sale to customers in the U.K. and other points around the globe. Presumably that includes the United States.

Unlike other popular boards such as the Raspberry Pi, the Micro:bit is not meant to be used as a standalone PC. Instead, it's a basic board for embedded projects such as a gaming device or a remote control. It's also compatible with more advanced micro PCs like the Raspberry Pi and Arduino boards for projects that require more processing heft.

The 1.6-inch by 2-inch Micro:bit comes with a 32-bit ARM Cortex M0 processor, 25 programmable LED lights arranged in a grid, two push buttons for user input, an accelerometer and compass, a micro-USB connector, and Bluetooth. The device was originally supposed to come with a slot for a watch battery, but the final design cut that, opting for a battery pack add-on instead that takes two AA batteries. You can find complete specs on the BBC's website (go.pcworld.com/bbcuk).

A new programmable computer wouldn't be much good without the tools to build something with them. To that end, there will be a new website to help students with their coding. The website will work on PCs or mobile devices, and lets students save and test their code on the site. Code can be written in standard languages including JavaScript, Python, C++, as well as Blocks (a visual programming

language) and Microsoft's Touch Develop (go.pcworld.com/touch). Once the code is ready for real-world action, they can transfer it to the Micro:bit via Bluetooth or a USB connection.

The Micro:bit is a huge collaboration between numerous tech companies including ARM, element14 (sellers of the Raspberry Pi), Microsoft, and Samsung.




Why this matters

A recurring debate in the tech world is whether there's any sense in teaching children to program. Some argue that programming is hard and, just as not everyone needs to know how to fix a car, not everyone needs to know how to program. But with computers becoming central to pretty much everything, there is value in learning some coding basics. Most of us remember enough from math class to know you have to multiply before you add. Similarly, a familiarity with how code works and a coding mentality to problem solving can go a long way in a technology-driven world.

Second time at bat

The Micro:bit is the BBC's second run at sparking the interest of students in computing. In 1981, the BBC worked with Acorn Computers to produce the BBC Microcomputer System (BBC Micro) sold primarily to schools in the U.K. as part of the BBC's Computer Literacy Project. The device was similar in form to a Commodore 64, a non-descript beige box with a keyboard that hooked up to a monitor or television.

Unlike the previous computer project, the Micro:bit will be distributed to individual students thanks to the ever lowering cost of components. It will also be 18 times faster at running code, 70 times smaller, and 617 times lighter than its predecessor, the BBC says (go.pcworld.com/bbcnews). 

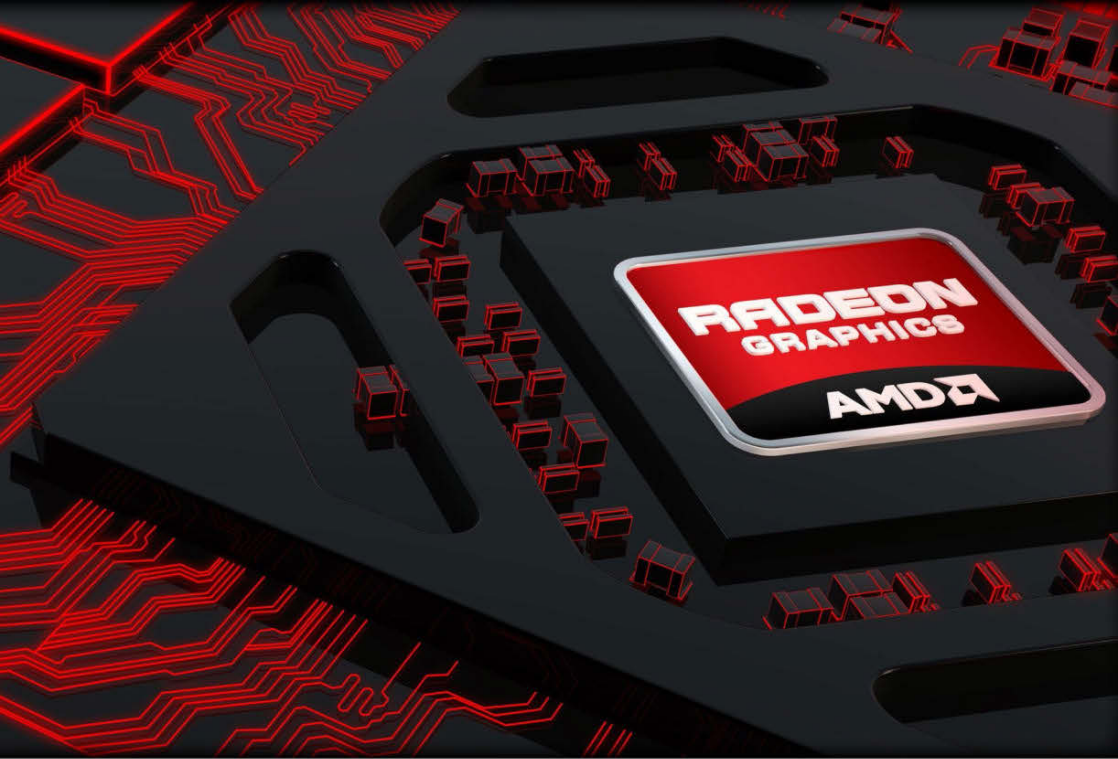
Welcome to Greenbot,
a website for
Android enthusiasts.



We've got the 'droid info you're looking for.
Helpful tips, critical reviews, and expert
analysis for passionate Android users
of every experience level.

www.greenbot.com





AMD Catalyst 15.7 drivers add pretty much every feature Radeon gamers begged for

BY BRAD CHACOS

AMD'S POLISHING UP SOFTWARE support for its new Fury X and Radeon R300 series graphics cards with the release of new WHQL-certified Catalyst 15.7 drivers. This sweeping update plays nicely with Windows 10, adds the clamored-for (and oft-delayed) CrossFire multi-GPU support for FreeSync monitors (go.pcworld.com/crossfire), and extends some of AMD's formerly exclusive features (like frame rate target control) to the full range of older Radeon R200 series graphics cards.

The Windows 10 support is no surprise, given that Microsoft's next-gen operating system launches as we go to press. Nvidia also recently pushed out Windows 10-compatible WHQL-certified drivers for its GeForce graphics cards. DirectX 12 cometh (go.pcworld.com/directx)! But beyond that, Catalyst 15.7's new offerings should have Radeon gamers shouting "Hallelujah!" from the rooftops.

THE STORY BEHIND THE STORY: AMD is often criticized for failing to release new WHQL-certified drivers at the same blistering pace as Nvidia. That said, the abundance of new goodies enabled in Catalyst 15.7 proves that AMD can stay feature-competitive with the GeForce gang, even if those features are released at a slightly slower pace—and they're sure to bring a smile to the faces of Radeon gamers everywhere.

What's new in AMD's Catalyst 15.7 drivers

The first of many improvements in the drivers is FreeSync support for CrossFire setups. AMD's FreeSync (and Nvidia's competing G-Sync) force your monitor and your graphics card to synchronize their refresh rates—hence the name—to provide a silky-smooth gaming experience free of screen-tearing and stuttering. Simply put, they rock.



The first FreeSync monitors rolled out in March, but without support for multi-GPU CrossFire setups. That was kind of a bummer: FreeSync rocks, but buying a FreeSync-compatible monitor essentially locks you into using Radeon-brand graphics cards for five to ten years. That makes it most appealing to AMD's Team Red diehards—aka, the very people most likely to be running a multi-GPU CrossFire setup. AMD had to cancel its initial plans to release CrossFire FreeSync support in April, stating “it's now clear to us that support for AMD FreeSync monitors on a multi-GPU system is not quite ready for release”—but now it is. Hallelujah! (AMD dual-GPU configurations that pair an APU with a single discrete graphics card aren't supported, however.)

More importantly for gamers with more modest setups, Catalyst 15.7 extends support for AMD's nifty Virtual Super Resolution and Frame Rate Target Control technologies to a wider range of older hardware.

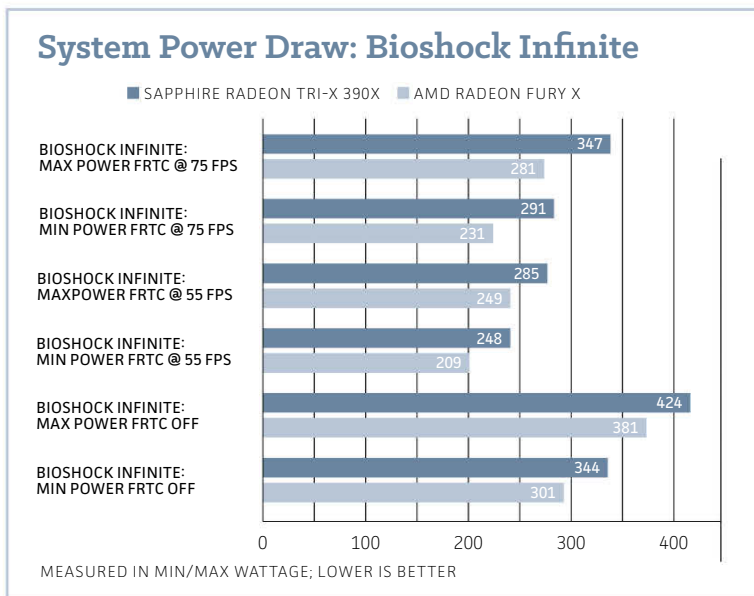
Virtual Super Resolution debuted with AMD's feature-stuffed Catalyst Omega drivers last December, but it worked only with a handful of high-end graphics cards (the R9 285, R9 290, R9 290X, and dual-GPU R9 295X2), ostensibly due to the need for internal hardware scalars. Well, somebody at AMD must have figured out some software trickery, because VSR is now supported on those GPUs, the full range of new Radeon R300 series graphics cards, and all Radeon R7 260 and

Targer Display Timing	Supported VSR Modes
1366 x 768 @ 60Hz	1600 x 900 1920 x 1080
1600 x 900 @ 60Hz	1920 x 1080
1920 x 1080 @ 60Hz	2560 x 1440 3200 x 1800 3840 x 2160 (R9 285, 380, and Fury X)
1920 x 1200 @ 60Hz	2048 x 1536 2560 x 1600 3840 x 2400 (R9 285, 380, and Fury X)
2560 x 1440 @ 60Hz	3200 x 1800
1920 x 1080 @ 120Hz	1920 x 1200 @120Hz, 2048 x 1536 @ 120Hz

above GPUs, along with all A-series 7400K and above desktop GPUs. (Hallelujah!)


Virtual Super Resolution forces your graphics card to render games at a higher resolution than your monitor natively supports, then downsamples the image to your display's native resolution when it's sent to your monitor. Doing so enables a far wider field of view in games and provides smoother edges on images—functioning kinda-sorta like anti-aliasing. Virtual resolutions up to a full 4K are supported, if your hardware and monitor both support it.

Frame Rate Target Control, on the other hand, appeared in the launch drivers for the Radeon R300 series graphics cards in June. This technology essentially lets you set a hard cap on your frame rates in games, which—as our extensive testing proved (go.pcworld.com/control)—can provide tangible, large benefits for both power and heat use when it's enabled with titles that push a tremendous amount of frame anyway.



Power savings

provided by enabling FRTC at various cap levels in BioShock: Infinite.

The fact that the feature was originally limited to new R300-series cards irked some Radeon faithful, as the GPUs at the heart of the new graphics cards are essentially retooled versions of the graphics processors that also powered the older R200 series. AMD's setting things right now, however, by extending support for FRTC to all Radeon R7 260 and above GPUs—just like with VSR. 

How many light bulbs does it take to change an American?



It's no joke: climate change is a critical issue for all life on Earth. But can the actions of one individual really make a difference? Visit nature.org to calculate your impact on the world around you and learn about steps you can take to make the world a better place for us all.

nature.org/calculate

The Nature
Conservancy 
Protecting nature. Preserving life.™



Giant mechs from Japan, U.S. will meet in epic robot battle

BY TIM HORNYAK

FRESH FROM ITS defeat in women's World Cup soccer, Japan wants to take on the United States once again—in giant robot combat.

Suidobashi Heavy Industry has agreed to a challenge from Boston-based MegaBots that would involve titanic armored robots developed by each startup.

While robot combat contests such as RoboGames are nothing new,

MegaBots'

Mark II robot.



the duel is being billed as the first of its kind involving piloted machines that are roughly 4 meters tall.

Unveiled in 2012, Suidobashi's Kuratas robot was designed by blacksmith Kogoro Kurata, who was inspired by the "mecha" robots of Japanese science fiction animation.

Weighing some 5,000 kilograms, Kuratas has three wheels, two arms, a one-person cockpit and various mock weapons that shoot pellets and fireworks. It was put on sale on Amazon Japan as a starter kit for ¥120 million (\$976,000) but is now listed as unavailable.

"We can't let another country win this," Kurata, who is CEO of Suidobashi, said in a video posted to YouTube ([go.pcworld.com/kuratas](https://www.youtube.com/watch?v=go.pcworld.com/kuratas)). "Giant robots are Japanese culture."

Suidobashi did not immediately respond to a request for more information.

The contest, which would take place next June, set the hearts of robot geeks aflutter after the challenge was issued in an over-the-top video ([go.pcworld.com/megabots](https://www.youtube.com/watch?v=go.pcworld.com/megabots)) by MegaBots that has notched more than 2 million views.

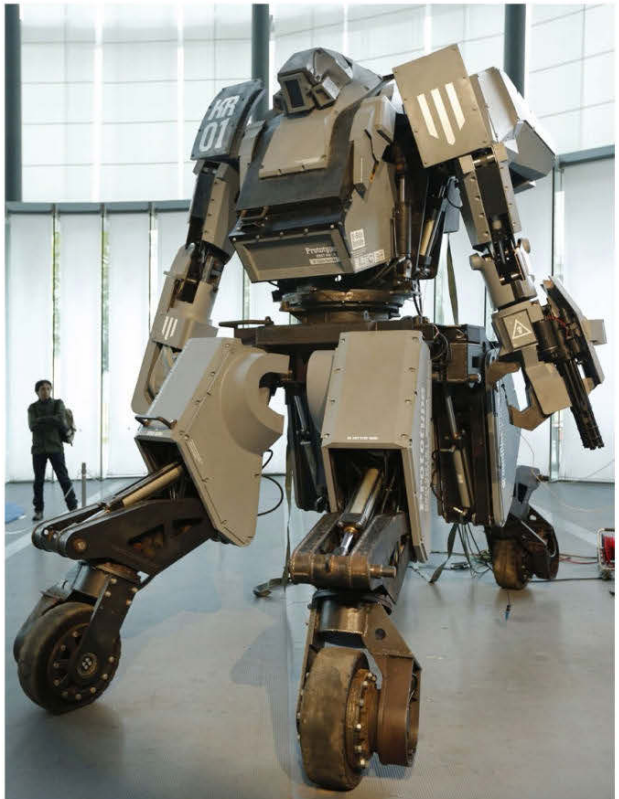
MegaBots' Mark II robot weighs some 5,400 kg, is piloted by a team

of two, and moves around on tank-like tracks. Its cannons can fire 1.3-kg paint balls at 161 kilometers per hour. The company wants to build enough robots to form teams that would fight in arenas, but its 2014 Kickstarter campaign (go.pcworld.com/kickstarter) failed to reach its goal of \$1.8 million.

Kurata said he wants the robots to be able to engage in a full-on knock-down fight to make the duel interesting.

Indeed, living up to audience expectations could be the most challenging aspect of the fight. Kuratas and MegaBots Mark II are very costly to make and carry human pilots, so allowing them to be destroyed or seriously damaged in battle would likely be out of the question.

But the spectacle would be better than other robot clashes, and could even form the basis for an annual piloted robot championship. As viewers of the recent DARPA Robotics Challenge finals (go.pcworld.com/darpa1) saw, contests involving autonomous robots can be painfully slow. Even the matches at RoboCup (go.pcworld.com/robocup), an international competition aimed at developing fleet-footed, dextrous robots that can beat the best human soccer players, can move at a glacial pace as droids clumsily try to dribble the ball, kick it, and then topple over. 🛑



Suidobashi
Heavy
Industry's
Kurata.

I was one of the **1** in **5**
Children in America who
STRUGGLE WITH HUNGER
join me and help put an
End to childhood hunger.

Viola Davis



**HUNGER IS
ALL OF US**

HELP UNDO CHILDHOOD HUNGER. GO TO HUNGERIS.ORG

THE
SAFeway
FOUNDATION

The *Hunger Is* campaign is a collaboration between The Safeway Foundation and the Entertainment Industry Foundation to raise awareness and improve the health of hungry children.

EIF
ENTERTAINMENT
INDUSTRY FOUNDATION

The Safeway Foundation and the Entertainment Industry Foundation are 501(c)(3) tax-exempt organizations. Photo by: Nigel Parry

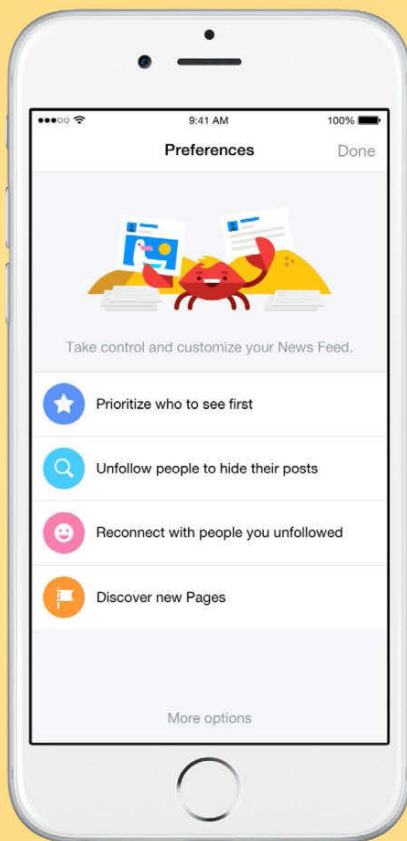
Make smart purchases,
stay safe online.

CONSUMER WATCH

Facebook lets you avoid the algorithm and control your own news feed

Sometimes humans are better
than machines at figuring out
what they want. Who knew?

BY JARED NEWMAN



AFTER YEARS OF sorting news feeds primarily by algorithm, Facebook is letting users choose what they want to see first. An update (go.pcworld.com/fbapp) to Facebook's iOS app expands the existing News Feed Preferences section with a way to choose whose updates appear at the top of

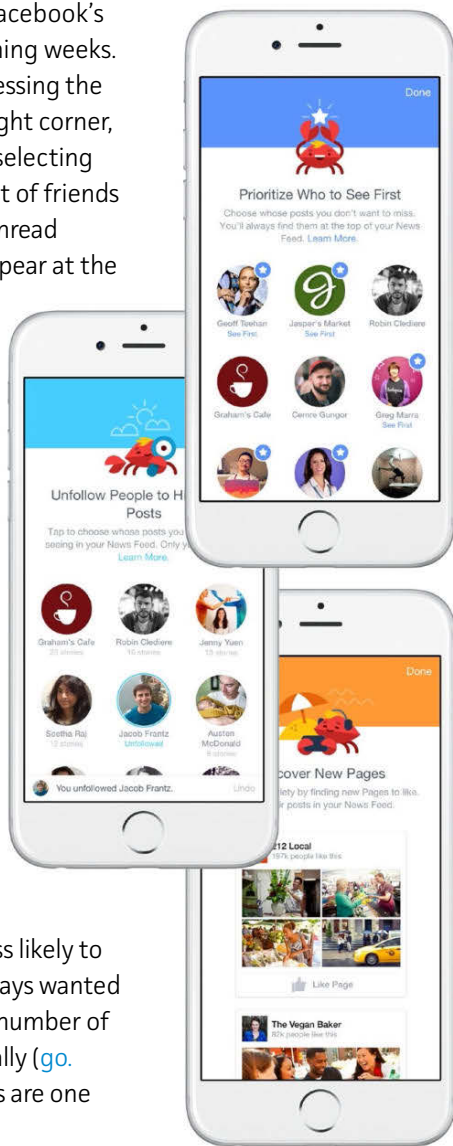
the timeline. A similar update is coming to Facebook's Android app and desktop website in the coming weeks.

Users can check out the new settings by pressing the More button in the Facebook app's bottom right corner, then tapping on News Feed Preferences and selecting Prioritize Who To See First. This brings up a list of friends and Pages that users can mark as favorites. Unread updates from favorite contacts will always appear at the top of the News Feed, overriding Facebook's predictive algorithms.

This preferences menu also lets users "unfollow" certain contacts, which simply hides their updates without severing the friendship. Other options include a way to discover new Pages based on ones that users have liked in the past, and a Reconnect menu that shows a list of unfollowed friends.

Why this matters

Until now, Facebook has relied extensively on its own algorithms to decide what users see, drawing on their histories of likes, comments, and other interactions. But machine learning doesn't always work perfectly, and can leave people with News Feeds that they're less likely to interact with in the first place. Users have always wanted ways around the algorithm—just look at the number of people trying to sort their feeds chronologically (go.pcworld.com/sort)—and the new preferences are one way to add greater flexibility. 📱





Privacy group file FTC complaint against Google

BY GRANT GROSS

GOOGLE'S REFUSAL TO implement the EU's controversial right-to-be-forgotten rules in the United States amounts to an unfair and deceptive business practice, a frequent critic of the search engine giant said.

Consumer Watchdog (consumerwatchdog.org) filed a complaint against Google with the U.S. Federal Trade Commission, said John Simpson, director of the group's Privacy Project. The complaint (go.pcworld.com/complaint) asked the FTC to rule that Google, by declining to delete search engine links on request from U.S. residents,

is an unfair business practice that violates the U.S. FTC Act (go.pcworld.com/usftc).

Arguing that the right to be forgotten is an “important privacy option,” Consumer Watchdog’s complaint stated that although Google claims to be concerned about users’ privacy, it doesn’t offer people in the United States “the ability to make such a basic request.”

“Describing yourself as championing users’ privacy and not offering a key privacy tool—indeed one offered all across Europe—is deceptive behavior,” the document reads.

Unfair business practices are defined in the FTC Act as those that cause substantial injury to consumers that they cannot reasonably avoid themselves and that are not outweighed by other benefits.

Before the Internet, it was difficult to track down records of the foolish things people did when they were young, Simpson said.

“This reality that our youthful indiscretions and embarrassments and other matters no longer relevant slipped from the general public’s consciousness is privacy by obscurity,” he said by email. “The Digital Age has ended that. Everything—all our digital footprints—are instantly available with a few clicks on a computer or taps on a mobile device.”

A Google representative didn’t respond to a request for comment on bringing the right to be forgotten to the United States.

Since launching as the Inside Google Project in late 2008, Consumer Watchdog’s Privacy Project has largely targeted Google, while paying significantly less attention to the privacy practices of several other Internet companies. Google representatives have questioned the impartiality of the group.

Under the European Union’s right-to-be-forgotten rules, residents of



Consumer Watchdog’s complaint to the FTC argues that the right to be forgotten is an “important privacy option.”

EU countries can ask search engines to delete links to information about them they find objectionable. The ruling, which went into effect in May 2014, does not require the information be deleted from the Internet, only that search engines not link to it.

The European Union's rule has been controversial, with some critics saying it amounts to censorship. "As a simple test, ask yourself whether this would be possible in the United States without a repeal or modification of the First Amendment—it would not," Wikipedia founder Jimmy Wales said last year.

The EU's rule has been controversial, with some critics saying it amounts to censorship.

Google, the largest search engine, has granted about 41 percent of the right-to-be-forgotten requests it has received in Europe. In several cases, Google has declined to remove links to news stories about criminal activity.

Google has managed right-to-be-forgotten requests in Europe in a way that is not "burdensome" to the company, Consumer Watchdog said. Since the European Union implemented the right-to-be-forgotten rule, Google has received about 1 million requests to remove links from its search engine.

Google's cost of reviewing requests should be part of its "reasonable cost of doing business as a search engine," Simpson said. The rule should apply in the United States not only to Google, but to other search engines as well, he added.

Consumer Watchdog has focused on Google because it is "so dominant as a search engine," Simpson said.

Consumer Watchdog is not attempting to bring strong EU privacy laws to the United States, Simpson added. But real people are being "hurt" by Google's failure to honor U.S. requests, he said.

"We're not arguing that European laws should apply in the U.S.," he said. "We're saying that aggressively marketing yourself as being concerned about consumers' privacy, but not offering a key privacy tool is deceptive." 🔌



*“I want
to be
a bench.
Recycle me.”*



IWantToBeRecycled.org



KEEP AMERICA
BEAUTIFUL



The vanishing: What happened to Google Street View's missing streets?

BY ZACH MINERS

WITH THE ARRIVAL of El Capitan (go.pcworld.com/elcapitan2) on Google Street View recently, you can now haul yourself virtually up one of the most famous rock faces in the world. Navigating certain streets in urban areas, however, can still be a challenge.

As Google expands Street View into ever more exotic places, it appears to have a problem in many of the towns and cities where the service has been available for years. Look closely at any major city,

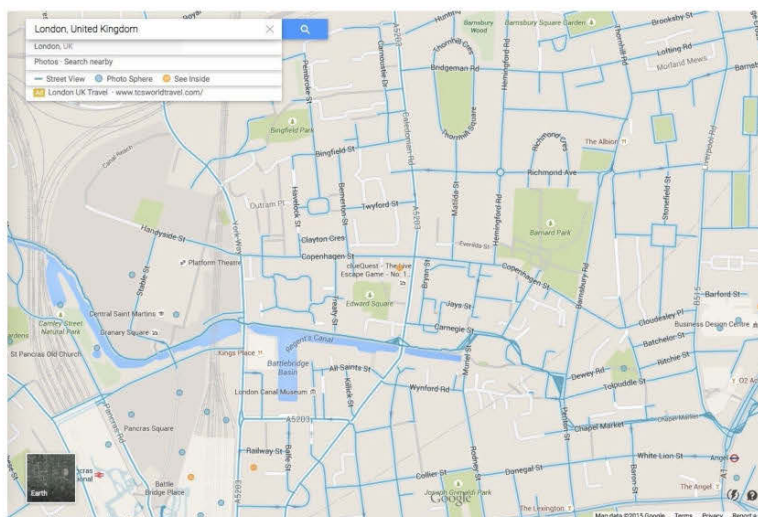
especially the residential areas, and Street View is littered with hundreds, even thousands, of little gaps. And although it's hard to be sure, the problem may be getting worse.

Street View is still a powerful tool and the gaps don't greatly diminish its utility—unless they happen to be in front of the building you're searching for. But it's strange that even in cities that Google's cars have photographed several times over, there are still numerous stretches—sometimes whole streets—where Street View imagery isn't available.

A bug, not a feature

Google called the gaps a “known issue” and implied it's due partly to a glitch in its early mapping software. But it refused to answer questions beyond that, including whether privacy requests are a factor, and whether the gaps are becoming more frequent.

“In places where we collected very early Street View imagery, the old data may sometimes cause an issue that prevents new images from surfacing,” the company said via email. “We've so far prioritized refresh of the bulk of the Street View imagery for our users, and we are certainly also working to fill these occasional gaps.”



The Barnsbury area of north London, where there are gaps in Street View, pictured July 2, 2015.

There are two types of gaps, broadly speaking. One is where a building has been blurred, which poses little problem for Street View explorers and is almost certainly due to a privacy request. Harder to fathom is where sections of streets are missing, signified by gaps in the blue lines that appear when you click on the yellow Street View icon in Google Maps.

There could be many reasons for the gaps, as Google has discussed in the past. In some cases, construction work may have prevented its mapping car from passing through. A wide swathe of Hunters Point (go.pcworld.com/hunterspoint) in San Francisco is missing, for example, but the images of adjacent streets show a lot of construction was going on. In other cases, a Street View driver might have skipped a street by accident, or the camera or recording software might have malfunctioned.

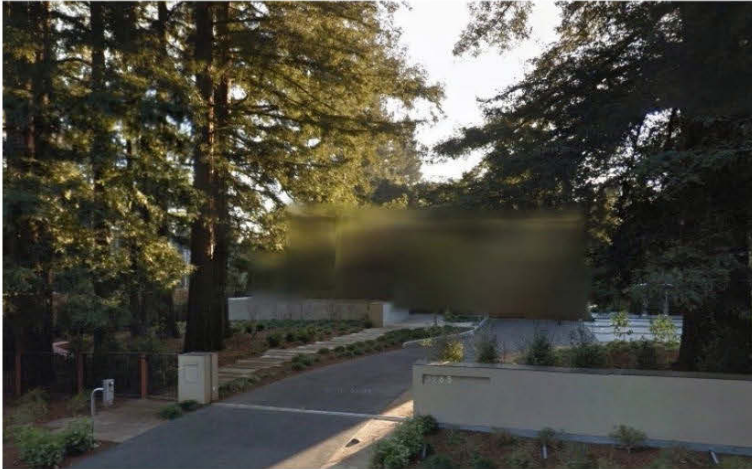
One possible culprit is that people have asked to have their homes blurred for privacy reasons.

Why wasn't this caught in subsequent visits?

But Google often revisits towns to update its imagery, and it's hard to see why the Sunset residential district in San Francisco, for example—more or less in Google's backyard—would have so many gaps (go.pcworld.com/gaps). The pattern is similar in Tokyo, London, Berlin, and many other cities around the world. The gaps aren't big, and it's possible to overlook them at first glance, but once you're aware they exist, they seem to appear all over the place.

One possible culprit is that people have asked to have their homes blurred for privacy reasons. Google explains on its Maps privacy page (go.pcworld.com/viewprivacy) how to request this, and it's a relatively simple process.

Famous people often file such requests. There's a gap in the Street View imagery outside Mark Zuckerberg's house in Palo Alto, for instance, although his home was visible in the past. But a lot of regular folk have asked to have their homes removed too, judging by



Google has blurred out the home of Sheryl Sandberg, Facebook's chief operating officer.

the prevalence of blurred images in residential areas.

In some cases, those blurring requests may have caused some of the gaps in Street View. If you approach the edge of a gap on a residential street, you can often zoom in and see a house in the missing section that's been blurred out. It's hard to be sure about the causes, though, since Google isn't talking.

Nein, says Germany


In extreme cases, whole countries are affected. Privacy has been a particular issue in Germany, where many people objected to the roll-out of Street View. Google now has Street View images only for big cities in Germany, like Berlin and Frankfurt, and appears to have given up on the rest of the country completely. Zoom out over Europe in Street View mode and Germany is mostly a blank island in (go.pcworld.com/blankisland) a sea of blue.

Some users have noted the gaps in a Google Maps forum (go.pcworld.com/mapforum), and they point to some strange examples. On the tiny island of San Andres in the Caribbean Sea, a Street View car appears to have driven a third of the way around the island's perimeter road and then stopped for no obvious reason. There are no

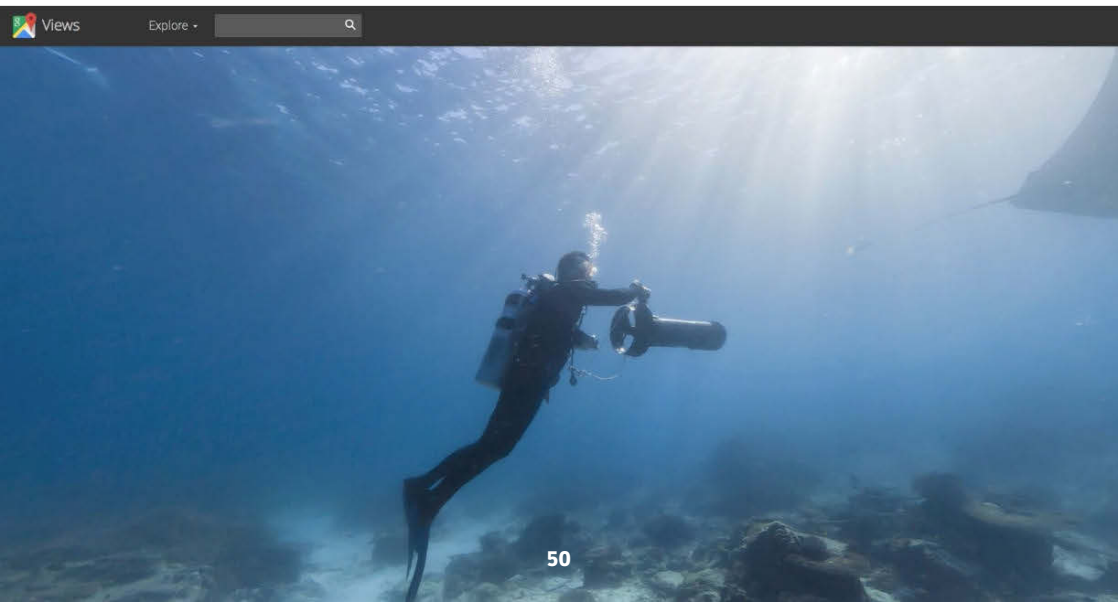
apparent obstacles or construction—though there does happen to be a bar by the side of the road where the car stopped capturing images.

There's another curiosity in San Francisco's Presidio Terrace, (go.pcworld.com/presidio) a gated community with a circular road and about two dozen homes. Most of it doesn't appear on Street View, but there are a few short stretches deep inside the complex that do. A telltale shadow shows that one of Google's cars was in there, but for some reason Google displays images for only a fraction of it.

Other reasons for gaps in Street View could include temporary lane closures, the construction of new roads since Google photographed an area, and safety issues that prevented drivers visiting certain streets, said Jon Froehlich, an assistant professor of computer science at the University of Maryland, College Park, who has used Street View imagery to study accessibility problems (go.pcworld.com/accessibility).

Plenty of exotic locales are impressively covered, however, and Google is adding more all the time. If you want to use Street View to check out the Great Barrier Reef (go.pcworld.com/reef)—where the fish apparently have no concerns about privacy—you can really go to town. 

This is the
southernmost
coral cay of the
Great Barrier
Reef.



Claire and Dad
Cleveland, OH



Take time to
be a dad today.



fatherhood.gov
877-4DAD411





T-Mobile says customers can roam in Canada, Mexico for free

BY MATT HAMBLIN

T-MOBILE ANNOUNCED that there would be no added charges for its U.S.-based Simple Choice customers when they call, text, or use data to Mexico and Canada or when traveling there.

The move makes T-Mobile the first carrier to offer continental phone service under a single plan anywhere in the world, company officials said.

The new Mobile without Borders plan means that customers can call from the United States to both countries for no added cost, as well as make calls from those countries when they travel in either one.

Both consumers and business customers will be eligible, although business customers will pay \$1 more per phone line for accounts with more than 10 phone lines, with no added cost for the first 10 lines.

T-Mobile CEO John Legere said the impact on business customers will be especially pronounced. About 70 percent of travel by small and medium-size businesses is to both countries, T-Mobile said, citing data from the travel industry. Also, 35 percent of all international calls across the phone industry were from the United States to the two countries last year.

Spiting Donald Trump

During a conference call (go.pcworld.com/conference) to announce the new plan, Legere blasted GOP presidential contender Donald Trump for his comments on wanting to build a wall on the U.S. border with Mexico, at a time when joint trade opportunities are expanding and the need for affordable communication and interactions is expanding. The new Mobile without Borders phone plan offers an alternative to the proposed wall, he contended, while jabbing at Trump.

“Donald Trump wants to put a wall up, but our phone coverage will work seamlessly” between the two countries, Legere said. “Don’t worry about the wall.” He quickly added: “Sorry, Donald, for hurting your major platform for running for president. Donald Trump is the gift that keeps on giving...He really is entertaining.”

Legere saved his biggest condemnation for AT&T CEO Randall Stephenson, for recently buying two Mexican wireless carriers for \$4 billion to be able to offer AT&T phone services there as well as in the United States. “Sorry, Randall, you are not the only and first” provider for Mexico and the United States, Legere said.

Reciprocal roaming

Legere said it wasn't necessary for T-Mobile to operate its own network in Canada and Mexico and will rely instead on the two largest carriers in each country to supply service. T-Mobile was able to forge reciprocal roaming deals with the four foreign carriers, which he didn't name, to lower traditional costs. In Mexico, Telcel, with 70 million customers, and Movistar, with 20 million, are the two largest carriers, according to recent industry data. In Canada, Rogers is the largest, with 9 million customers, while Telus and Bell are nearly tied, with 8 million apiece.

Those T-Mobile partners have plenty of 4G LTE service in major cities that offer fast data services, Legere said.

Even though T-Mobile has expanded

LTE coverage in the United States, critics often ding the carrier for having weak or spotty coverage outside of major U.S. cities. Analysts said it remains to be seen how thorough the coverage is in Canada and Mexico.

T-Mobile was able to forge reciprocal roaming deals with the four foreign carriers, which Legere didn't name, to lower traditional costs.

International appeal

Even with such concerns, analysts said the new plan will appeal to travelers, both consumer and business.

"T-Mobile is stealing the industry's—and especially AT&T's thunder—by expanding the free calling area to Mexico and Canada," said Roger Entner, an analyst at Recon Analytics. "The new plan is most appealing to people who, no surprise, call and travel to Mexico and Canada the most."

T-Mobile posted details on Mobile without Borders for consumers (go.pcworld.com/consumer) as well as for business customers (go.pcworld.com/bconsumer) on its website.

For business customers using Mobile without Borders, T-Mobile

adapted its Un-carrier for Business (go.pcworld.com/uncarrier) plans announced in March.

Business plans affected, too


Under the March announcement, the first 20 business lines would cost \$16 a line (or \$15 a line for 21 lines or more) per month, which includes voice and text and 1GB of data. With the Mobile without Borders plan, the first 10 business lines cost nothing extra, but there is a \$1 added cost per phone line for 11 or more lines, T-Mobile officials said.

With the Mobile without Borders plan, 50 percent of the calls, texts, and data used every three months must be done from inside the United States. That restriction keeps the plan devoted to U.S.-based customers, T-Mobile said.

The March business plan was immediately so successful that it produced a 120 percent increase in traffic flow into 3,000 T-Mobile stores, Legere said. T-Mobile might provide more details on the bottom-line impact of its business plans when it announces earnings on July 30, he hinted.

"Overall, we've been astounded" by the interest from businesses, said Rakesh Mahajan, senior director of marketing for @Work at T-Mobile. Some customers have said they didn't realize T-Mobile was in the market for business customers.

Mahajan said Mobile without Borders could be expanded beyond Mexico and Canada to other countries. "We started with the biggest opportunity and customers will figure out where we go next," he said. Legere and other officials didn't commit to offering such a plan in Europe, when asked.

Mexico, in particular, has been an attractive market because trade barriers have been lowered in recent years, meaning more U.S. businesses are working with manufacturing partners in Mexico, he said. 



Two worlds.
One dream.

Singers and Scientists share more than might be expected. Whether it's a breakout melody or a breakthrough in research. When it comes together, everything fits. It can change lives forever.

Stand Up To Cancer supports the collaboration, innovation and research that are turning discoveries into viable treatments and possibly, one day, a cure.

Stand up with us. Let your voice make a difference because when we work together, nothing is impossible.



Genentech
A Member of the Roche Group

Like, share and join SU2C.
Find out more at standup2cancer.org

Jennifer Hudson, Stand Up To Cancer Ambassador

Shiva Malek, Ph.D.

REVIEWS & RATINGS

CONTENTS

- | | | | |
|----|--|-----|--|
| 58 | Hardcore Hardware:
We stuffed this PC
with 128GB of cutting-
edge DDR4 RAM | 88 | Radeon R9 Fury X
graphics card: AMD's
long awaited
4K powerhouse |
| 65 | Lenovo YogaTablet 2
Anypen (8-inch)
review: Yes, you can
write on it with a fork | 102 | Tested: AMD's Frame
Rate Target Control
delivers real benefits
for Radeon gamers |
| 70 | M-Disc optical media
reviewed: Your data,
good for a thousand
years | 108 | Batman: Arkham
Knight: How bad are
the issues? Pretty bad |
| 76 | EVGA GeForce GTX
980 Ti Superclocked+
unleashes Maxwell's
true power | 114 | Batman: Arkham
Knight (PC): Holy
squandered potential,
Batman |

TESTED IN PCWORLD LABS

In this section, hardware & software go through rigorous testing.

REVIEWS & RATINGS



Hard-core hardware: We stuffed this PC with 128GB of cutting-edge DDR4 RAM

The 64GB barrier in system memory is now broken by DDR4 RAM in Intel's Haswell-E. Watch us tear down that wall.

BY GORDON MAH UNG

HUMANS LIKE TO CELEBRATE BARRIERS being broken. The speed of sound. The first 1GHz processor, or 1TB hard drive.

So get ready to pop the California sparkling wine, because we just smashed right through the 64GB system RAM barrier.

That barrier, if you didn't know, has vexed consumer computing for years now. Mainstream desktop PCs have all featured four slots for a maximum of 32GB of DDR3 RAM. At the high end, prosumer PCs doubled that to eight slots for a maximum of 64GB DDR3.

With the move last year to DDR4 RAM in Intel's Haswell-E, we were promised we'd finally break the 64GB mark. That time has come.

Both Corsair and Kingston recently announced 128GB memory kits using 16GB DDR4 memory modules. We had to try one out.

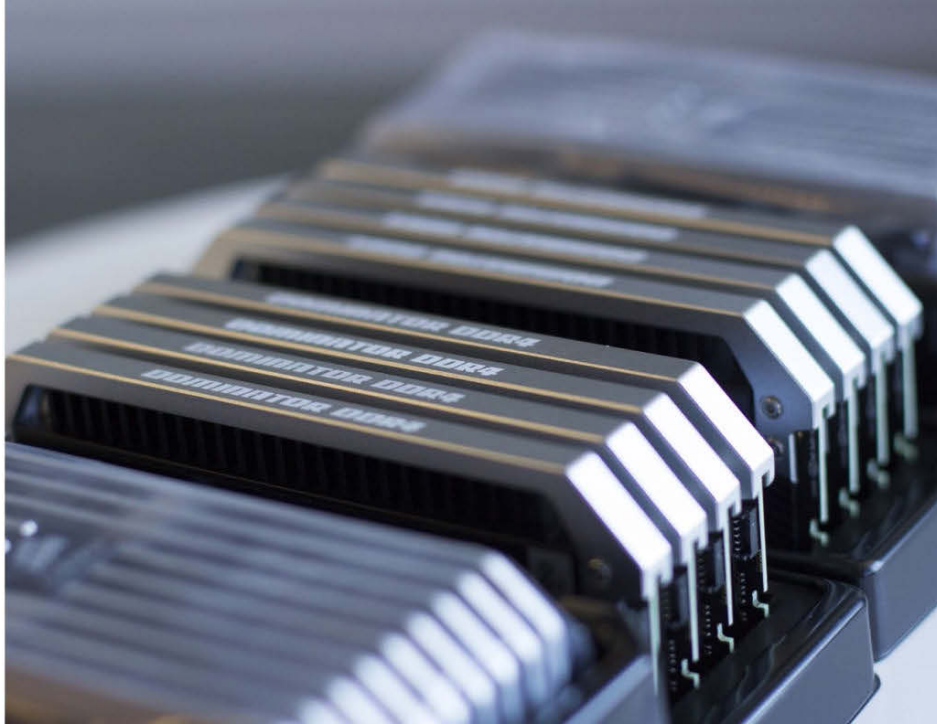
What made this possible

If you're wondering why we've been locked in at 64GB for so long, it's mostly due to the technology and process changes. DDR3 modules topped out at 8GB, in what's typically called an unbuffered DIMM. You



Watch the
video at
go.pcworld.com/128gbamvid





could actually get higher-capacity modules in DDR3, but they were only in registered or buffered DIMM. These memory modules are meant for servers or workstations, which typically cost an arm and a leg and run at much slower speeds, because they sacrifice density for reliability.

The move to DDR4 last year with Intel's Haswell-E CPU also promised higher-density chips. While DDR3 maxed out at 8GB, DDR4 now maxes out at 16GB per module.

Here's what
128GB of DDR4
looks like.

Corsair Dominator Platinum

To break the barrier, we reached out to Corsair for its 128GB kit (go.pcworld.com/corsair128gbram). The company actually has three speeds: DDR4/2800, DDR4/2666 and DDR4/2400 at the Platinum level. The kit we used was the DDR4/2400, and it comprises eight 16GB modules. It comes in a matched set with two heat-sink fans. The module's not cheap: The fastest DDR4/2800 set is \$2,120, while the two lower-speed kits are \$1,980. In true computer tradition, though, prices have already begun to fall. Corsair has since released its Vengeance LPX line at the same density and speed for \$1,600.

What you need

Not everyone can get to 128GB of RAM. Obviously, you need eight memory slots. You'll also need a CPU that supports DDR4, but you don't need a \$1,000 Xeon or Core i7-5960X CPU. For this particular test I used Intel's cheapest Haswell-E CPU, a Core i7-5820K. The final ingredient that you'll need is a motherboard whose BIOS supports 128GB of RAM.

When I first plugged the 128GB of RAM into our Asus X99 Deluxe/U3.1 board and threw the switch, it wouldn't boot. Only after obtaining a beta BIOS from Asus would the board POST. The good news is, I'm told by Asus that it expects to roll out support across its X99 board lineup as we speak. I expect other motherboards to support 128GB of RAM, too, as the modules become more common.

Once I updated the board to the latest BIOS, all went as expected without any hitches. The OS I used on our PC was Windows 8.1 Enterprise. If you still don't believe I got the bottom-feeder Core i7-5820K to work with 128GB of RAM, here's proof.



One of the first
128GB DDR4 kits
out is Corsair's
Dominator
Platinum that'll
set you back
\$1,980.

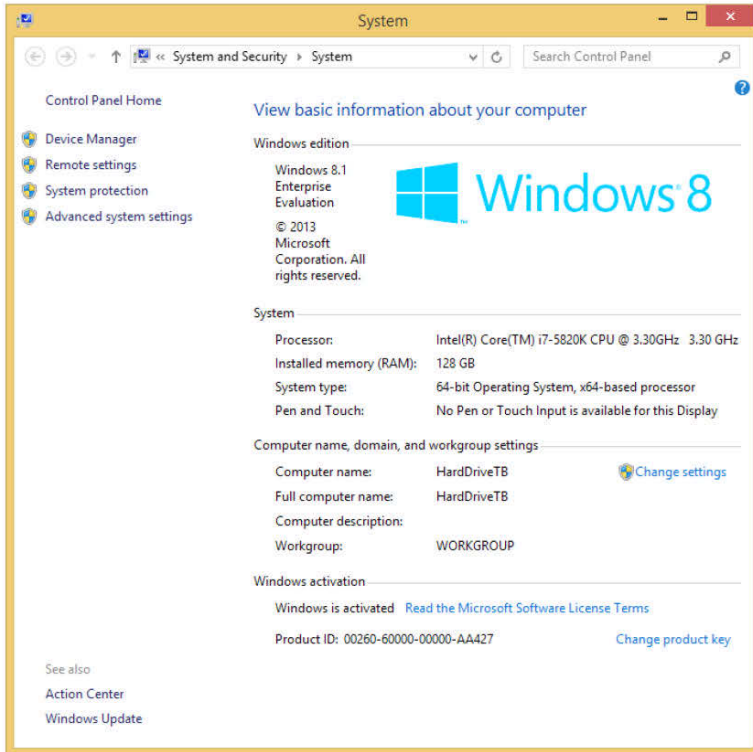
Uhh, now what?

I'll admit, I was giddy firing up a PC with 128GB of RAM in it, but once I was booted I experienced a "now what" moment of doubt. Few people need more than 16GB of RAM, and some can even get by with 8. Outside of the 1-percenters who may need 64GB of RAM for extreme Photoshop, virtualization, or multitasking, it's just not needed.

To make use of this glorious amount of hardware, I settled on creating one massive RAM disk. RAM disks use your system's RAM to

We needed a beta BIOS for the Asus X99 Deluxe U3.1 to get the 128GB of RAM working in our system.





simulate a storage “disk.” They’ve been around for years but typically are far smaller due to the constraints of memory. Not everyone needs a RAM disk, but if you need access to temporary storage that puts even the most powerful SSDs to shame, a RAM disk is the way to do it.

I fired up Softperfect RAM disk and dialed in a 100GB RAM disk. Here’s what’s so great about the RAM I had: Even with a 100GB RAM disk, I had 28GB or so of memory left to work with.

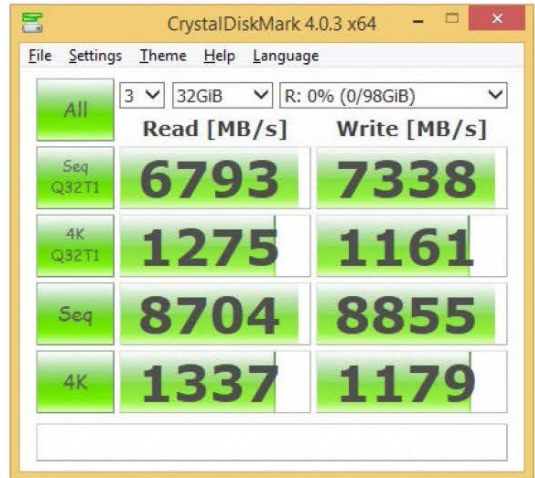
To find out just how fast this RAM disk could be, I ran Crystal Disk Mark. As you can see, the performance puts any SSD to shame. The mighty Intel 750-series SSD, for example, has a sequential read speed of maybe 2.7GBps. The RAM disk was hitting 8.7GBps.

RAM disks have one pretty big downside: if there’s a sudden power

outage or serious BSOD, kiss goodbye anything you had in the RAM disk that wasn't previously saved. It's gone baby, gone.

It's obvious I'm reaching for use cases for this much RAM, but there are people out there who legitimately need this capacity. It's just not for 99 percent of us. What this really is about, though, is finally breaking through the 64GB barrier.

Yes, 128GB of system RAM seems silly, but if you dial back the clock, people used to say that about 16MB of RAM and 1GB of RAM. One day, I can say with confidence, we'll look back and laugh at how silly we were to be in awe of 128GB of RAM—when we're all running 1TB and counting. 🔌





Lenovo Yoga Tablet 2 Anypen (8-inch): Yes, you can write on it with a fork

BY JON L. JACOBI

WHEN LAST I COMMUNED with a Windows-powered Lenovo Yoga Tablet 2 (the 10-inch version), the event was soured by the worst auxiliary keyboard I've ever experienced. Thankfully, Lenovo didn't see fit to saddle the Windows version of the smaller \$300, 8-inch Yoga Tablet 2 Anypen (go.pcworld.com/yogatablet2anypen) with something similarly irritating. The Yoga Anypen is a neat little tablet

with an innovative design and versatile digitizer, though not necessarily a platform for serious business use.

What 'Anypen' means

The headline feature of the Yoga Tablet 2 Anypen is its advanced digitizer. You can use a pencil, ballpoint pen, or just about anything with a metal tip 1mm or larger. Most digitizers require a capacitive stylus with at least a 5mm tip. You might want to avoid X-Acto knives, but other than that you're good to go. You may, of course, also use your fingers.

Another unique aspect of the Yoga Tablet 2 design is the cylinder running along one edge that allows for a far larger battery than a normal, flat tablet can accommodate. The battery tube also allows a grip that uses all your fingers, yet doesn't place your thumb near the display. Many is the time I've accidentally flipped pages on an iPad mini.

The Yoga Tablet 2 (both sizes) has a distinctive kickstand that jackets the battery tube. It clicks into place at about 42-, 85-, and 180-degree angles, but you can manage angles in between due to the large amount of friction. Even more unique is the hole in the kickstand for hanging the Yoga Tablet 2 on a wall, for storage or an ad-hoc cinematic experience.

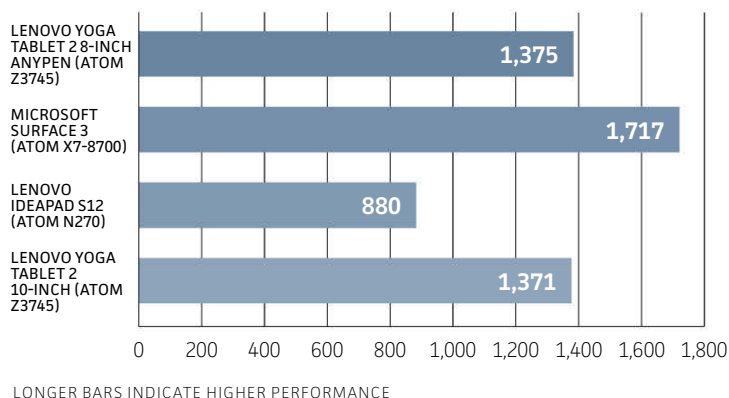
Beyond that, the Yoga Tablet 2 Anypen (with Windows) is, well, a smallish Windows tablet running Windows 8.1. Its outstanding feature in that regard is the free year of Office 365.

Hardware-wise, you're

The cylinder at its base lets you grip the tablet and also lets Lenovo put in a massive 6,400mAh battery.



PCMark 8 Work Conventional



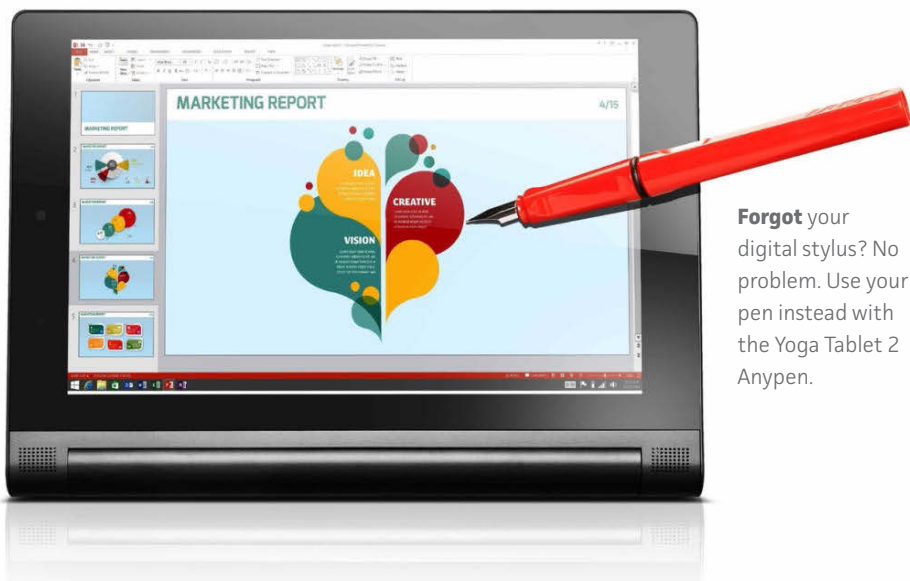
The Yoga 2's performance easily eclipses the older Atom used in the S12 Netbook, but the newer Surface 3's Cherry Trail Atom clearly stays ahead.

talking a Bay Trail Atom Z3745 CPU, 2GB of DDR3/1066 system memory, an 8-inch 1,920 x 1,200 touchscreen display, and a 32GB eMMC SSD—generally nice specs, but not a lot of disk space for running Windows. Indeed, with only 19.7GB of free disk space before we installed anything, we were unable to use our 20GB data sets for read/write testing.

Performance and run time

In my hands-on, the Yoga Tablet 2 Anypen seemed lively enough, but the numbers are strictly Atom: PC Mark 8 rated the tablet at 1,375 in the work test and 897 in the creative test. 3D Mark didn't measure playable frame rates until it got to Ice Storm Extreme, a Web graphics game where the Tablet 2 Anypen scored 7,967. While that's quite nice compared to last-generation Atoms, it's not Core-like. Overall performance, in fact, is pretty much identical to the 10-inch version's (go.pcworld.com/yogatablet2). In fact, you could look at the 10-inch Yoga Tablet 2 results from our Surface 3 review (go.pcworld.com/surface3review) and pretend it's the 8-inch version and not miss a beat.

Regardless, there were no frustrating waits thanks to the Samsung



Forgot your digital stylus? No problem. Use your pen instead with the Yoga Tablet 2 Anypen.

MBG4GC SSD, which scored 168MBps reading and 75MBps writing 4MB files under CrystalDiskMark. That's quite good for an eMMC-based SSD.

Battery life was 6 hours and 58 minutes, and that's measuring with PCMark's battery rundown test, which works uninterrupted. Unless you drink a lot more coffee than I do, you can add a few hours to that figure.

Multimedia and connectivity

The Yoga Tablet 2 Anypen rendered 1080p movies quite nicely, and the sound is adequate. There's plenty of volume, enough to create distortion if you crank it up all the way. The stereo separation is also better than average, due to the placement of the speakers on either end of the battery tube. The microSD card slot on the back can expand storage if you want to keep a decent collection of movies on board.

The only ports on the Tablet 2 Anypen are the headset jack and the micro-USB port, which can be used for temporary storage as well as charging the unit, or conversely, charging other devices. Having that large battery on board is handy. The Wi-Fi is 802.11 a/b/g/n, and there's Bluetooth for connecting peripherals. Alas, there's no WiDi or

even MHL support via the microUSB, so with the lack of video ports, you really are stuck with the 8-inch display.

As with any tablet worthy of the name, there are cameras: an 8-megapixel back-facing one for snapping photos, and a 1.6-megapixel front-facing one for Skyping and the like.

The 8- or 10-inch dilemma: Size vs. weight


When it comes to mobile computing of the business kind, I generally recommend larger displays and keyboards. My theory is that usage far exceeds tote time, so go for the best computing experience. However, when it comes to tablets, smaller means lighter (the Anypen weighs a measly 0.94 pounds) and easier to hold.

As the Yoga Tablet 2 also comes in Android flavors, though without the Anypen digitizer, the display-size (8- or 10-inch) buying decision is complicated.

As the Yoga Tablet 2 also comes in Android flavors, though without the Anypen digitizer, the display-size (8- or 10-inch) buying decision is complicated. The 8-inch version is better as a tablet, but should you then be opting for Windows? For real work, the screen items and text are small even when you magnify to 150 percent. I had to skip all the way to 200 percent (a custom setting) before my admittedly bad vision was comfortable using Windows. At that point, the extra pixels are basically wasted.

Conclusion

The 8-inch Yoga Tablet 2 Anypen (with Windows) is a nicely realized tablet with long run time that lets you use just about anything as a stylus (I used a fork once). It's good for tablet tasks, and the occasional light business chore, by all means.

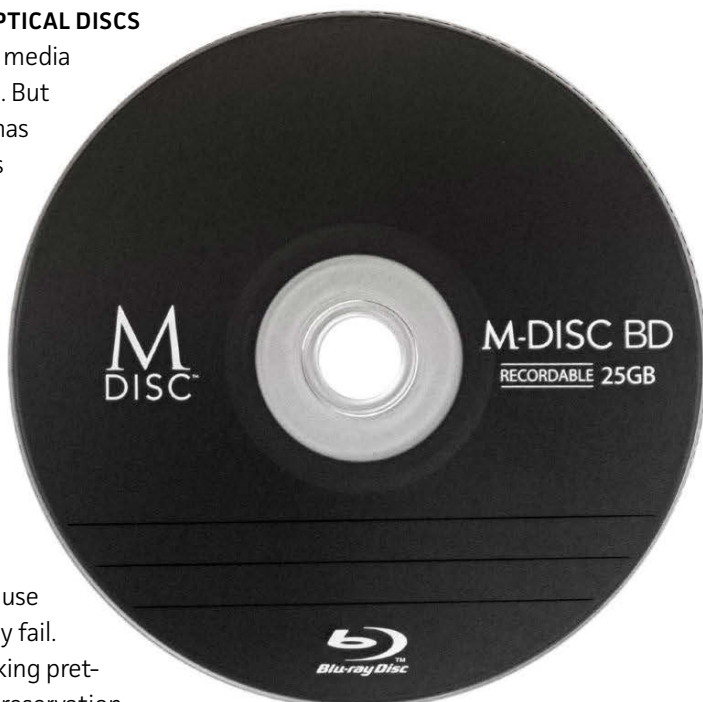
For extensive business usage, opt for the 10-inch Yoga Tablet 2 but forgo Lenovo's misbegotten BC800 keyboard. Or, if I'm really going to be honest, buy an 11- to 13-inch laptop. 

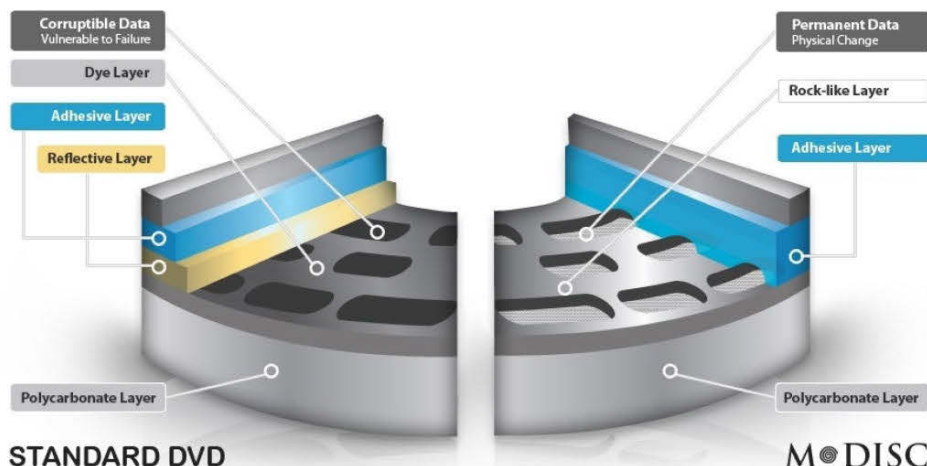
M-Disc optical media reviewed: Your data, good for a thousand years

BY JON L. JACOBI

YOU'RE DONE WITH OPTICAL DISCS

as a means of data and media delivery, or soon will be. But when done right, as it has been with Millenniata's M-Disc (mdisc.com), optical has a particular advantage—longevity. Hard-disk mechanisms fail, and the data stored on them can be erased by magnetic fields. Tape stretches and is also magnetically vulnerable. NAND won't last forever, because cells leak and eventually fail. That leaves M-Disc looking pretty good in the media-preservation, aka archiving, role.





Optical is dead. Long live optical.

In the enterprise, optical has enjoyed continued success. Companies such as Sony and Panasonic have continued development both because of its longevity and the minimal environmental support it requires. You think your hard drive generates a lot of heat? Try operating thousands of them. AC bills can be rather high.

The advent of relatively unstable, dye-based CD/DVD recordable and rewritable, as well as the lack of quality standards governing them, caused many users to forget that pressed optical discs are very long-lived. CDs from the 80's and 90's should still play fine, assuming you haven't scratched them up. Same deal with DVD and Blu-ray movies, which are manufactured similarly. And, even though few are aware of it, write-once BD-R HTL (High to Low, i.e., reflectivity, as in bright to dark) is rated to last 100 to 150 years. Why? Because the data layer is a non-volatile substance, as opposed to the light-sensitive organic dye used in CD/DVD-Rx and less expensive BD-R LTH (Low to High, dark to bright).

M-Disc also uses a non-volatile data layer, but it's an even better, rock-like one which is said to last ten times longer than BD-R HTL. If

This diagram illustrates the difference between dye-based and inorganic recordable optical discs.

you can't trust media that's rated for 1,000 years, you're pickier than I am. One note: Don't freak out when you see an M-Disc DVD+R. It's nearly transparent, but there is a data layer present.

DoD tested

As to that thousand-year claim, the U.S. Navy will back that up. It tested M-Disc DVD+Rs along with archival-quality DVD+R/RW and DVD-R/RW, subjecting them three times to a 185-degree, 85-percent humidity, full-spectrum light environment for 26.25 hours. Every DVD failed—except the M-Discs, which suffered no noticeable degradation. The Department of Defense hasn't tested the new M-Disc BD-R, but as the technology is largely the same, the results should be as well. (We'd guess that BD-R HTL would survive as well.)

The only failure point for the material used in the M-Disc data layer is oxidation, which, according to Millenniata materials scientists, shouldn't be an issue for about ten millennia. Yikes. The comparative delicacy of the polycarbonate outer layer of the disc is why the media lasts “only” a thousand years.



You should see a logo like this on compatible DVD burners.

DVD and Blu-ray Compatibility

I'm not going to live a thousand years, so the only thing I could test was compatibility. Millenniata was nice enough to send me an M-Disc-compatible optical writer, the Samsung/TSST SE-506CB.RSBD, for write testing. I also tried a vintage 2006 Plextor PX-B320SA, but it didn't recognize the M-Disc BD-R media as legitimate media for writing.

As BD-R HTL was part of the Blu-ray standard, and M-Disc functions much the same way, any BD burner is physically capable of writing M-Disc BD media. But as my experience with the PX-B320SA proved, if the firmware doesn't like it, it won't work.

The logo on the front of an optical burner is actually only for M-Disc

DVDs, and then only for writing, as many non-logo drives will read it just fine. Laser strength must be increased beyond that normally used with CD/DVD R/RW to ablate the data layer in M-Disc DVDs, so compatible firmware must be in place. Older drives could be upgraded for writing, but as there's little financial incentive, don't hold your breath.

The SE-506CB.RSBD burned flawlessly, so I took the discs it created and tried to read them using every drive I could find. M-Disc says its recordable DVDs should be readable in 90 percent of the DVD drives installed, or being sold now. I didn't hit 90 percent, but even though recognition could be slow, the majority of the drives I tested read M-Disc just fine (see the table on the next page).

Though your old drive might work fine, if you're going to commit to



optical for the long haul, it might not be a bad idea to grab one of the latest, greatest Blu-ray burners. Make sure it supports triple-layer, 100GB BDXL for less disc swapping.

Not dirt-cheap and other negatives

M-Disc released 4.7GB

DVD discs, which are suitable for archiving documents and perhaps your most treasured photos, last year. For video or other larger files, the recently released 25GB and 100GB BD-R, as well as the soon-to-be-released (Q3) 50GB BD-R discs should take care of business.

But M-Discs aren't cheap. At retail, the DVDs are about \$3, the 25GB discs about \$5, the upcoming 50GB discs around \$10, and the 100GB \$20 or so. Just keep in mind that this is not media that you'll have to roll over every few years, as with CD/DVD R/RW or dye-based BD-R LTH. It's a one-time deal. At least until the next technological storage shift.

Because the media is expensive and not as capacious as a hard drive, you'll have to choose what's really important and perhaps divvy it up across discs. You may view this either as an opportunity to clean house or as a deal-buster.

Also, as always, optical is relatively slow: M-Disc BD discs write at a rather pokey 4X/18MBps (6X/27MBps is the BD max), and M-Disc DVD is also 4X, or 5.28MBps. That's way off the DVD maximum, which is 16X

Make and Model	Read M-Disc DVD	Read M-Disc BD-R
LG WH16N540	Yes	Yes
Asus DRW-24B1ST	No	N/A
Teac DV-W516C	No	N/A
Matshita BD-MLT UJ272	Yes	Yes
Matshita UJ8B0AW	Yes	N/A
TSST SN-208FB	Yes	N/A
Teac DV-W28S-V	Yes	N/A
Plextor PX-B320SA	Yes	Yes




M-Disc BD-R
three-pack.

or 21MBps. But it's a once-in-a-while deal, so just start your backup, minimize it, and go on about your business.

Why not online archiving?

Online archiving is certainly an option, but even in the age of ubiquitous broadband, online storage is relatively slow, even slower than optical in many cases. And relatively expensive. And unavailable when communications systems are down. You don't know who has access to the data, and you don't know how well the data center is backed up.

Yes, I have a streak of paranoia, but it's born of experience. There's nothing quite like knowing there's a backup in your safe deposit box or at your relatives' house. Not that you shouldn't store a copy online as well.

I'd strayed from optical for all the usual reasons: lack of speed and capacity, expense, bad discs, etc. But I'm back and fully intend to keep my most important data, the stuff that can't be replaced, archived on M-Disc. BD-R HTL would do, but just in case I do live a thousand years, I'll use M-Disc. 

There's nothing quite like knowing there's a backup in your safe deposit box or at your relatives' house. Not that you shouldn't store a copy online as well.

EVGA GeForce GTX 980 Ti Superclocked+ unleashes Maxwell's true power

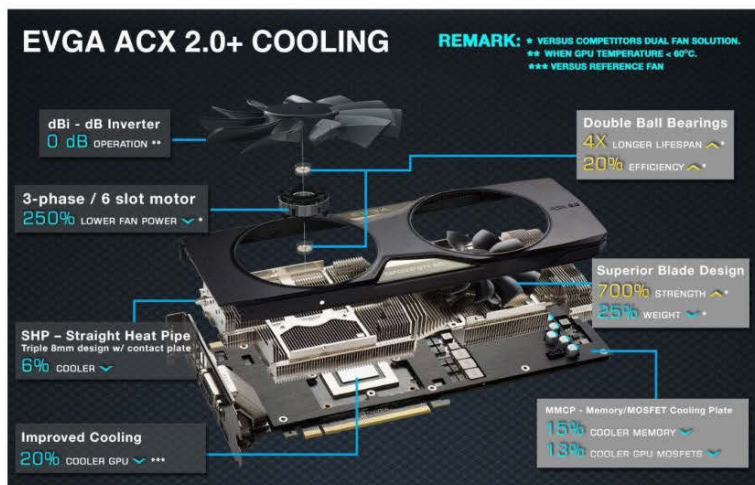
BY BRAD CHACOS

I EAGERLY ANTICIPATED reviewing the most powerful single-GPU graphics card to ever grace PCWorld's test bench—and I wasn't disappointed. But the card that claimed that title wasn't the one I expected! While AMD's new, hotly anticipated Radeon R9 Fury X is a beast in its own right, the title of new heavyweight champion instead lies with EVGA's \$680 GeForce GTX 980 Ti Superclocked+ with ACX 2.0+ (go.pcworld.com/evgagtx980ti), a custom-cooled, overclocked variant of Nvidia's ferocious GTX 980 Ti.

EVGA sent me this card out of the blue on the same day I received the Fury X—a coincidence, I'm sure. But the GTX 980 Ti Superclocked+ doesn't just triumph over AMD's



Details about the
EVGA GeForce
GTX 980 Ti
Superclocked+'s
ACX 2.0+ cooling
solution.



new flagship, it outpunches Nvidia's own \$1,000 Titan X in raw firepower.

What's more, even though AMD's dual-GPU Radeon R9 295x2 still manages to outrun EVGA's beast, the GTX 980 Ti Superclocked+ illuminates a key advantage the 980 Ti family holds over all other 4K-capable graphics cards.

Let's dig in!

EVGA GeForce GTX 980 Ti Superclocked+ under the hood

For the most part, EVGA's card rocks the same basic tech specs as the reference GTX 980 Ti, which we covered in full in our initial review of Nvidia's gaming Goliath (go.pcworld.com/nvidiagtx980rev). You find the same 2,048 CUDA cores, the same 6GB of GDDR5 memory with a 7Gbps clock speed and a 384-bit bus, the same port selection, et cetera. You can find more details about Nvidia's GM200 chip itself in our earlier review. The chart on the next page has the basic technical information, specifically for the EVGA GTX 980 Ti Superclocked+ (henceforth to be referred to as the GTX 980 Ti SC+).

So what makes the EVGA GTX 980 Ti SC+ so special? The (full) name

gives it all away. The card ditches the GTX 980 Ti's reference cooling in favor of EVGA's respected ACX 2.0+ cooling system, which has made an appearance on several Nvidia GPUs at this point. Rather than talking about its dual fans, custom heat pipe, MOSFET cooling pipe, and quiet operation yet again, we provide an EVGA-supplied diagram showing it all on the previous page. You'll see the results in our benchmarking section.

The other tell-tale in the name is *Superclocked+*. The drastic cooling enhancements provided by ACX 2.0+ let EVGA

Specifications

- Base Clock: 1102 MHz
- Boost Clock: 1190 Mhz
- Memory Clock: 7010 Mhz Effective
- CUDA Cores: 2816
- Bus Type: PCI:E 3.0
- Memory Detail: 6144MB GDDR5
- Memory Bit Width: 384 Bit
- Memory Speed: 0.28 ns
- Memory Bandwidth: 336.5 BG/s

Dimensions

- Height: 4.376in – 111.5mm
- Length: 10.5 – 266.7mm
- Width: Dual Slot

DVI-I

DISPLAY
PORT

DISPLAY
PORT

DISPLAY
PORT

HDMI

Getting that kind of overclock out of the box, with full 3-year warranty support, is no joke.

While the stock GTX 980 Ti is clocked at 1,000MHz base clock/1,075MHz boost clock, EVGA's managed to coax those numbers up to 1,102MHz base/1,190MHz boost in the GTX 980 Ti SC+—a sizeable jump.

Getting that kind of overclock out of the box, with full 3-year warranty support, is no joke.

If you want to push things even further—or boost the memory speed, which is left untouched from stock



The EVGA
GeForce GTX
980 Ti Super-
clocked+'s
backplate.

on the GTX 980 Ti SC+—you can turn to EVGA’s stellar PrecisionX overclocking software, which is available as a free download on EVGA’s website (go.pcworld.com/precisionx) or via Steam (go.pcworld.com/precisionxsteam). It’s a great solution, blending user-friendliness with the fine-tuning features power users demand. Need a primer? PCWorld’s overclocking guide (go.pcworld.com/overclockgc) refers to MSI’s competing Afterburner tool, but the same basic overclocking principles apply with PrecisionX.

One final design tidbit: EVGA’s GTX 980 Ti SCi+ comes with an eye-catching custom backplate installed. Unlike the vanilla GTX 980, the reference GTX 980 Ti eschewed a backplate, ostensibly to facilitate better airflow in multi-GPU setups, but I’m a sucker for a nice backplate. Who wants to stare at exposed circuit boards?

EVGA GeForce GTX 980 Ti Superclocked+ benchmarks

With that out of the way, let’s get to the fun part.

As always, we reviewed the GTX 980 Ti on PCWorld’s graphics testing system. You can see how we built the system here, but here are the basics:

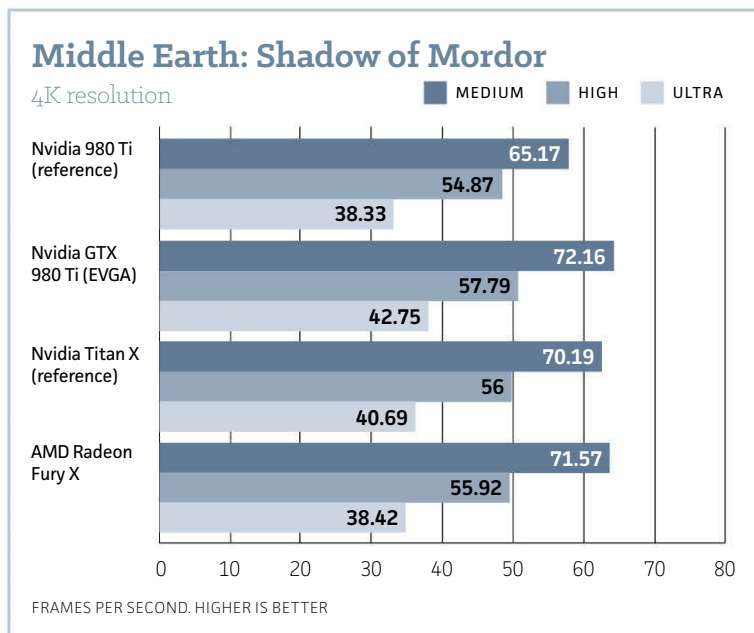
- Intel’s Core i7-5960X with a Corsair Hydro Series H100i closed-loop water cooler, to eliminate any potential for CPU bottlenecks affecting graphical benchmarks
- An Asus X99 Deluxe motherboard
- Corsair’s Vengeance LPX DDR4 memory, Obsidian 750D full

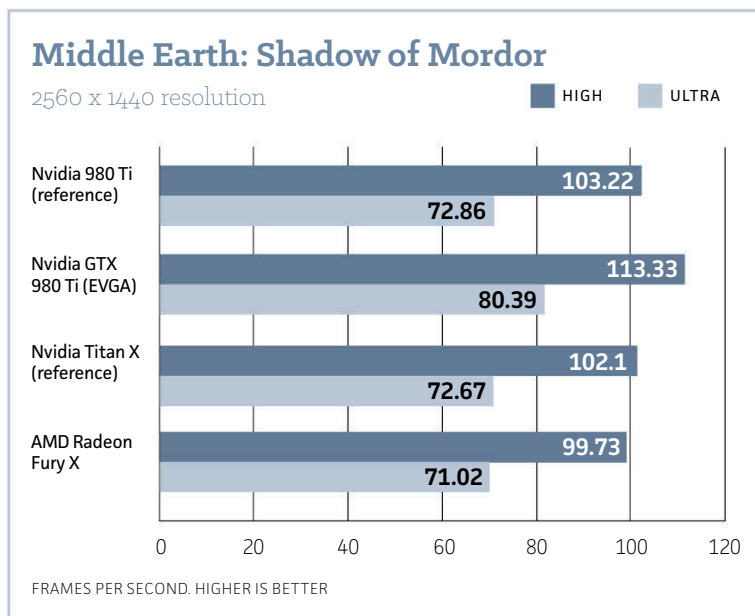
tower case, and 1200-watt AX1200i power supply

- A 480GB Intel 730 series SSD
- Windows 8.1 Pro

I've already spoiled the results by calling this the fastest graphics card we've ever tested, but if you're looking to game at high or ultra graphics settings at 4K resolution, the same caveats mentioned in our Fury X, Titan X, and reference GTX 980 Ti still apply. While all of these cards are fully capable of handling 4K gameplay by their lonesome, frame rates can still hover between 30 to 60 fps in some titles, depending on the settings you're using.

A G-Sync monitor, which forces your graphics card and display to synchronize frame rates, greatly improves the experience when gaming at 4K by smoothing everything out and essentially killing both screen tearing and stuttering. Simply put, G-Sync (and AMD's competing FreeSync displays, designed for Radeon cards) are wonderful. If you can afford to pick up a G-Sync monitor to pair with

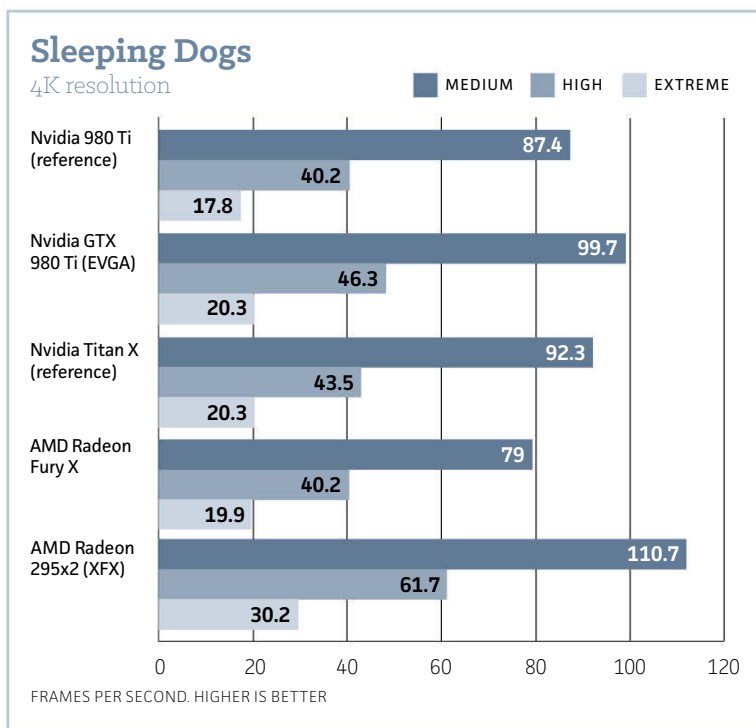




EVGA's GTX 980 Ti SC+, it's highly recommended.

The GTX 980 Ti's cranked clock speeds help it shine in every test I ran. First up: *Middle-earth: Shadow of Mordor*. The game itself is great, but more importantly, it comes with an in-game benchmark and an optional Ultra HD Textures pack that hammers the memory of even the most capable cards on the market today. It's tested using the game's Medium and High presets, then shifting to the Ultra preset and then cranking every graphics option to its highest possible setting—which even the Ultra preset doesn't actually do. (Note: No matter which drivers I'm using, I just can't coax *Shadow of Mordor* into playing nice with AMD's dual-GPU Radeon R9 295x2.)

The long-awaited *Grand Theft Auto V* is finally available on PCs, and with all the bells and whistles on, it can be a bear. We tested it by enabling all the advanced video options, then shifting all the graphics settings and sliders to their highest settings. I tested it with 4x MSAA and 4x MSAA reflections enabled to push the active memory use over



4GB, as well as with the MSAA options disabled to bring it just under 4GB—primarily to test the Fury X’s 4GB of cutting-edge high-bandwidth memory at 4K resolution. To see complete benchmark results from all of our tests, go to go.pcworld.com/evgabench.

Sleeping Dogs: Definitive Edition is a recent remake of a wonderful older game, but don’t let that fool you: It can make even the most powerful graphics cards in the land sweat when you enable all its graphics options. Only the Radeon R9 295x2 hits 30 fps at 4K resolution, and although results at 2560 x 1600 resolution aren’t shown here, not even that card can hit 60fps at that lower resolution on extreme graphics settings.

Alien Isolation is the best xenomorph experience since the original *Alien* movie, and when it comes to graphics, it scales well across all hardware.

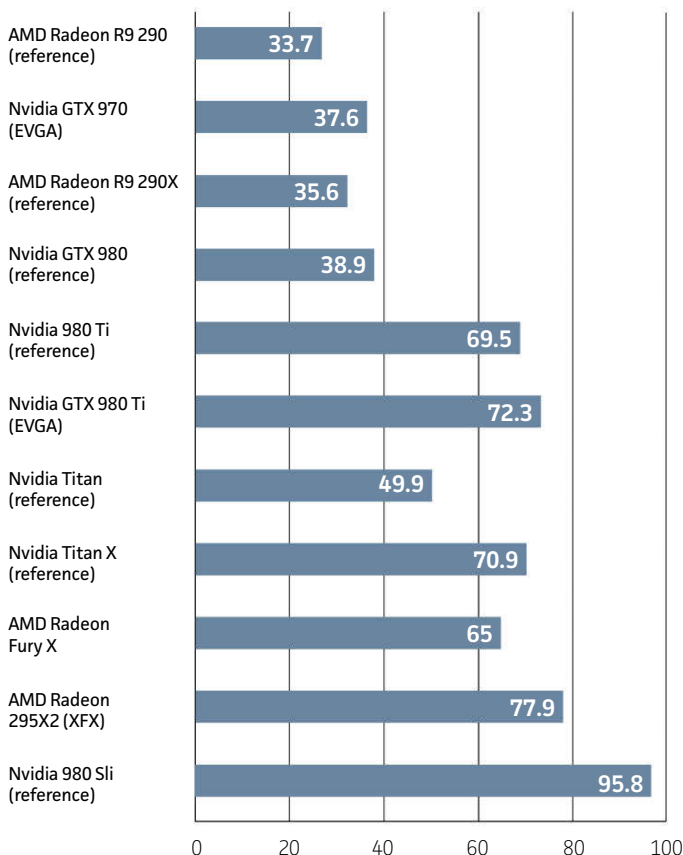
Dragon Age: Inquisition is drop-dead gorgeous and one of the best PC games of 2014. Despite being heavily promoted by AMD at its launch, the game performs better on Nvidia hardware.

We tested *Metro Last Light Redux* with SSAA and Advanced PhysX disabled. SSAA cuts frame rates in half for negligible visual gain.

Bioshock Infinite is getting a bit long in the tooth, but it uses the

Unigine Valley

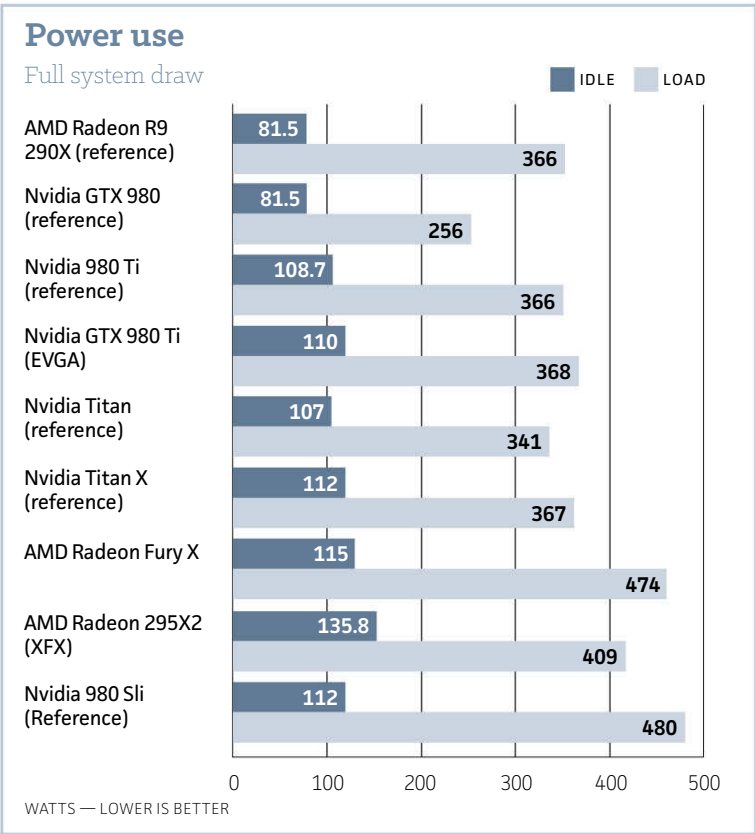
2560 x 1600 resolution



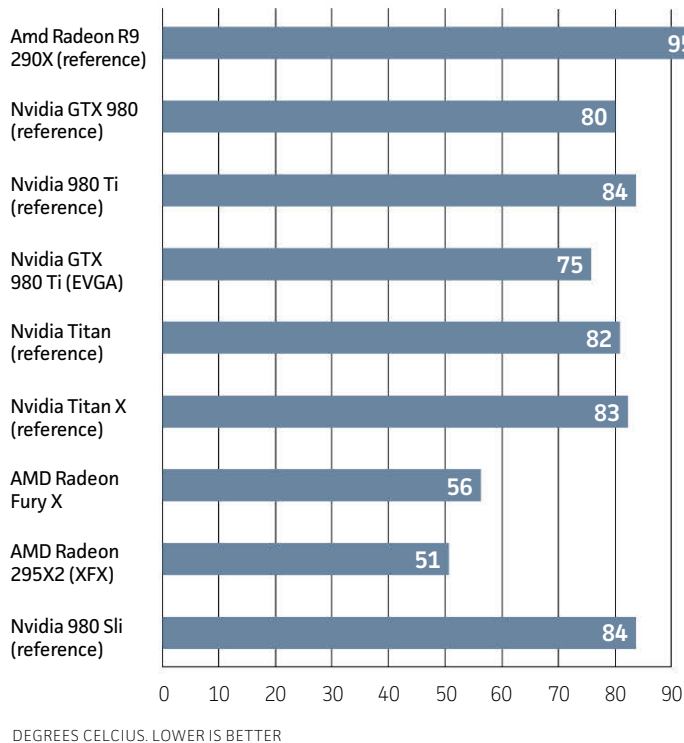
popular *Unreal Engine 3* and both AMD and Nvidia have had plenty of time to optimize their drivers for the game by this point.

Next up: The 3DMark Fire Strike and Unigine Valley synthetic benchmark tests. Fire Strike Ultra is a more demanding variant of the base Fire Strike benchmark, built specifically to test 4K gaming capabilities.

Power usage and thermal testing is conducted by running the grueling Furmark tool for 15 minutes. Thermals are measured at the end of the run, using both Furmark's built-in temperature tool as well as SpeedFan. Power usage is measured on a whole-system basis, rather than the individual cards themselves, by plugging the PC into a



Maximum GPU temperature under load



Watts Up meter.

The GTX 980 Ti SC+’s custom cooling solution helps it shave a full 9 degrees Celsius off the power use at load when compared to the reference GTX 980 Ti. And while it doesn’t show in the raw benchmarks—I don’t have a decibel meter on hand—EVGA’s card runs pretty damned quiet, even when you’re hammering it with a demanding game. (Though obviously not as cool or quiet as AMD’s Fury X and R9 295x2, each of which uses an integrated closed-loop water cooler.)


Bottom line

The EVGA GeForce GTX 980 Ti Superclocked+’s outstanding performance comes as no surprise. The reference GTX 980 Ti was already a beast in every sense of the word, so slapping a slick custom cooler on it and cranking the clock speeds was guaranteed to turn the GTX 980 Ti SC+ into a true barn-burner. EVGA’s excellent build quality and design thoughtfulness is just icing on the delicious cake.

You could push frame rates to even more blistering levels with esoteric liquid-cooling solutions that allow for higher overlocks—witness EVGA’s own GeForce GTX 980 Ti Hydro Copper and GeForce GTX 980 Ti Hybrid, with their insane 1,228MHz boost clock speeds out of the box, for evidence of that. Meanwhile, some other cards, like MSI’s GTX 980 Ti Gaming 6G, manage to push the boost clock speeds beyond that. Those cards would no doubt hit frame rates even higher than the ones the GTX 980 Ti SC+ achieved here.

But as it stands, the EVGA GeForce GTX 980 Ti Superclocked+ is hands-down the fastest single-GPU graphics card we’ve ever tested, barely coming in second to only the formidable dual-GPU Radeon R9 295x2 (and its integrated closed-loop water cooler) in our testing. It’s a thrilling example of the kind of firepower that a custom-cooled, sped-up GTX 980 Ti can bring to the table—something that the flagship Titan X and Fury X can’t offer, with Nvidia and AMD locking those cards down to reference designs only.

Hail to the new king, baby.

Finally, the sterling performance of the \$680 GTX 980 Ti SC+ is yet more proof that gamers should pass on the beastly \$1,000 Titan X, even with the latter’s 12GB of RAM. If you picked up one of those Titan X’s when it was the clear lord of the land a few scant months ago...well, there’s a reason that graphics card lust is the cruelest obsession. 



Ready.gov/business



Up to 40% of businesses never recover after experiencing a major disaster. Do you have a plan to keep your business running if disaster strikes? For a free online tool that helps you develop an emergency plan, visit [Ready.gov/business](https://www.ready.gov/business).

WHERE WILL DISASTER LEAVE YOUR BUSINESS?

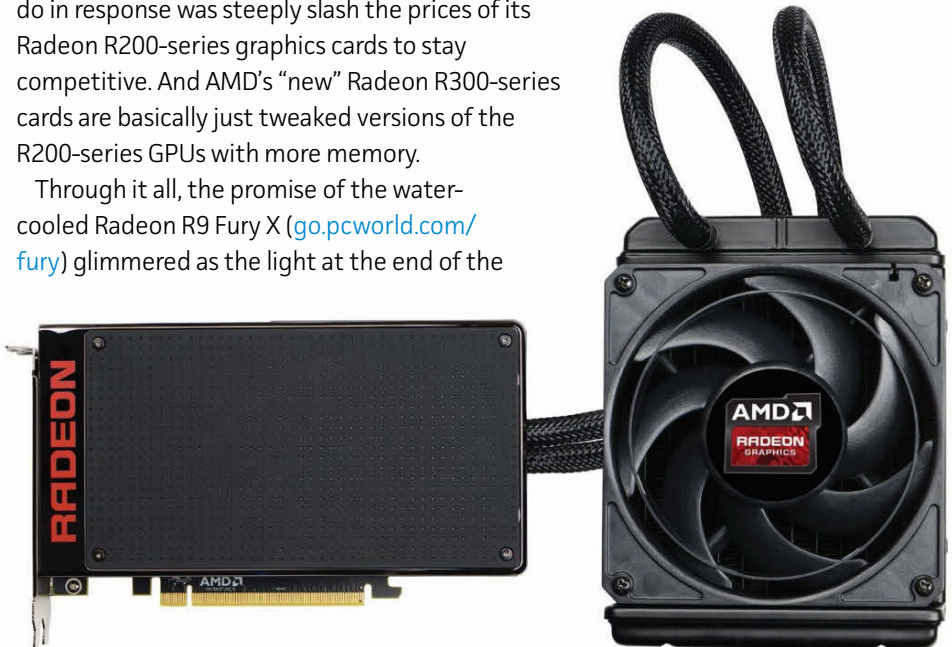
Radeon R9 Fury X graphics card: AMD's long-awaited 4K powerhouse

BY BRAD CHACOS

AMD'S RADEON R9 Fury X kicks ass.

It's important to note that right up front, because AMD's graphics division has had a rough year. The company's been forced to watch Nvidia release not one, not two, but five new GeForce graphics cards—the entire GTX 900-series line—since the Radeon R9 285 launched last September. What's more, those GeForce cards delivered so much performance and sipped so little power that all AMD could do in response was steeply slash the prices of its Radeon R200-series graphics cards to stay competitive. And AMD's “new” Radeon R300-series cards are basically just tweaked versions of the R200-series GPUs with more memory.

Through it all, the promise of the water-cooled Radeon R9 Fury X (go.pcworld.com/fury) glimmered as the light at the end of the



tunnel, first through unofficial leaks and then through official reveals. It'll have cutting-edge high-bandwidth memory! It'll have a new Fiji graphics processor with an insane 4,096 stream processors! It'll have an integrated closed-loop water cooler! It'll play 4K games and go toe-to-toe with Nvidia's beastly Titan X and GTX 980 Ti!

And it's all true. Every last bit of it. The Radeon R9 Fury X kicks ass.

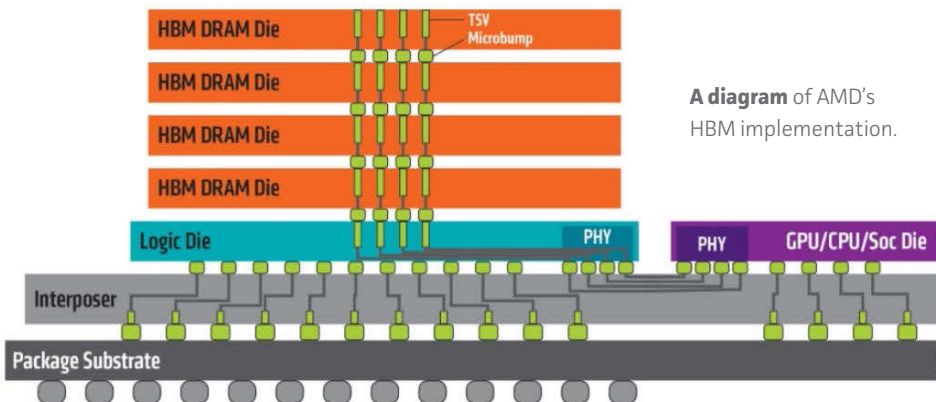
It's not quite the walk-off home run that Team Red enthusiasts were hoping for, however—and AMD's claim that the Fury X is “an overclocker's dream” definitely does not pass muster.

Let's dig in.

AMD's Radeon R9 Fury X under the hood

There isn't much mystery to the Fury X's technical specifications at this point. AMD long ago provided a deep-dive into the card's HBM implementation (go.pcworld.com/hbm) and described the Fury X's technical and design details (pcworld.com/furyxtechspecs) with loving exactness. We'll cover the high points here, but check out our previous coverage if you're looking for more details.

The most notable technical aspect of the Fury X is its use of high-bandwidth memory, making it the first graphics card to adopt HBM. AMD says it's been developing the technology for seven years, and



A diagram of AMD's HBM implementation.

Nvidia's not expected to embrace similar technology until 2016 at the earliest, when its Pascal GPUs launch.

HBM stacks DRAM dies one atop the other, then connects everything with the GPU using “through-silicon vias” and “ μ bumps” (microbumps). The stacking lets 1GB of HBM consume a whopping 94 percent less on-board surface area than 1GB of standard GDDR5 memory, which enabled AMD to make the Fury X a full 30 percent shorter than the Radeon R9 290X.



HBM space
savings over
GDDR5.

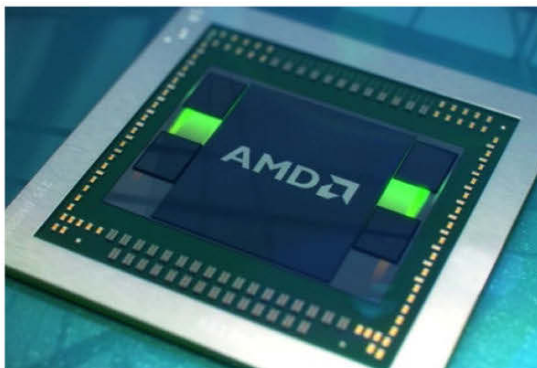
While GDDR5 memory rocks high clock speeds (up to 7Gbps) and uses a smaller interface to connect the GPU—384-bit, or 512-bit in high-end graphics cards—HBM takes the opposite approach. The Fury X's memory is clocked at a mere 1Gbps, but travels over a ridiculously wide 4,096-bit bus to deliver effective memory bandwidth of 512GBps, compared to the GTX 980 Ti's 336.5GBps. All that memory bandwidth makes for great 4K gaming, though it doesn't give the Fury X a clear edge over the 980 Ti when it comes to games, as we'll see later.

Technological limitations capped this first-gen HBM at just 4GB of capacity. While AMD CTO Joe Macri told us in May that's all developers really need for now, it definitely proved to be a problem in our testing when playing games that gobbled up more than 4GB of RAM—*Grand*

Theft Auto V, specifically. Gaming at 4K resolution can eat up memory fast once you've enabled any sort of anti-aliasing.

Moving past memory, AMD's new Fiji GPU is nothing short of a beast,

packed to the gills with a whopping 4,096 stream processors—compared to the R9 290X's 2,816—and 8.9 billion transistors. It's clocked at 1,050MHz, promises 8.6 teraflops of compute performance, and draws 275 watts of power through two 8-pin power connectors that can draw up to 375W.



AMD's Fiji GPU.

The Radeon R9 Fury X over the hood

AMD spared no expense on the physical design of the Fury X, either. The 7.5-inch card is built from multiple pieces of die-cast aluminum, then finished with a black nickel gloss on the exoskeleton and soft-touch black everywhere else. Everything's covered, even the sides and back of the card. There's not even an exhaust grille on the I/O plate, which rocks a trio of full-sized DisplayPorts and an HDMI port that's sadly limited to the HDMI 1.4a specification. The decision not to go with HDMI 2.0 limits 4K video output to 30Hz through the HDMI port, so gamers will want to stick to using the DisplayPorts.

You'll find an illuminated red Radeon logo on the outer edge and face of the card, along with a new "GPU Tach" (as in "tachometer") feature that places 8 small red LEDs above the power connections. The harder you push the card, the more LEDs light up. It's super-dumb but honestly, it thrilled me to no end watching those little LEDs flare to life when booting up a game. There's also a small green LED next to those that illuminates when AMD's ZeroCore technology puts the Fury X to sleep. This thing screams "premium."

That extends to the Fury X's cooling system. Rather than going with a typical air-cooling solution, with a fan or blower, the Fury X utilizes an integrated closed-loop liquid cooler that's basically a more refined version of the beastly Radeon R9 295x2's water-cooling setup. It's a slick custom design built in conjunction with Cooler Master, rocking a 120mm fan from Nidec on the radiator. AMD says the cooler itself is rated for up to 500W of thermal capacity.

Deploying water-cooling indeed keeps the Fury X running nice and cool. Despite AMD's claim that the fan stays more than 10 decibels quieter than the Titan X's air-cooled blower, however, I was surprised by just how much noise it puts out. Subjectively—as I don't have a decibel meter on hand—the Fury X's radiator fan creates more sound



See the GPU
Tach LEDs just above the two 8-pin power connectors?

	AMD Radeon™ R9 Fury X Series
Process	28nm
Stream Processors	4096
Engine Clock	Up to 1050MHz
Compute Performance	8.6 TFLOPs
Texture Units	256
Texture Fill-Rate	268.8 GT/s
ROPs	64
Pixel Fill-Rate	67.2 GP/s
Z/Stencil	256
Memory Configuration	4GB HBM
Memory Interface	4096-bit
Memory Speed / Data Rate	500MHz / 1.0Gbps
Memory Bandwidth	512 GB/s
Power Connectors	2 x 8-pin
Typical Board Power	275W
PCI-E Standard	PCI-E 3.0
API Support	DirectX® 12, Vulkan™, Mantle
FreeSync Support	Yes
Virtual Super Resolution	Yes
Frame Rate Targeting Control	Yes

The AMD Radeon R9 Fury X's technical specifications.

than the fan on Nvidia's reference GTX 980 Ti and AMD's own R9 295x2, though I still wouldn't call it loud.

The braided cables connecting the radiator to the card itself are a nice touch and far more aesthetically appealing than the R9 295x2's plastic tubes. Be mindful of where you place the discrete radiator/fan combo, however: At 2.5 inches of total

width (the same as the R9 295x2's), they jut far enough into the case of PCWorld's GPU testing machine (go.pcworld.com/diygamingpc) to bang against our CPU's closed-loop liquid cooling.

Final design note: You won't be able to buy aftermarket variants of the Fury X with custom cooling or hefty overlocks applied by add-in board vendors like Asus or Sapphire. AMD says the Fury X is a reference design only, though the air-cooled Radeon R9 Fury has vendor-customized designs available.

The elephant in the room

Normally, this is where I'd leap into gaming benchmarks, but I wanted to talk about a more advanced issue first: overclocking.

With power pins capable of sucking down 100W of additional energy, a liquid-cooling solution rated for up to 500W of thermal capacity, and a redesigned AMD PowerTune/OverDrive that gives you more control over fine-tuning your card's capabilities, the Radeon R9 Fury X seems tailor-made for hefty overclocking. Heck, AMD even touted the card's overclockability (that's a word, right?) at its E3 unveiling. "You'll be able to overclock this thing like no tomorrow," AMD CTO Joe Macri said. "This is an overclocker's dream."

That's... well, that's just not true, at least for the review sample I was given.

I was only able to push my Fury X from its 1,050MHz stock clock up to 1100MHz, a very modest bump that added a mere 1 to 2 frames per second of performance in gaming benchmarks. You can't touch the HBM's memory clock—AMD locked it down. And any time I tried upping the Fury X's power limit in AMD's PowerTune utility, even by 1 percent, instability instantly ensued.

An AMD representative told me that "We had a very limited number of OC boards." When I asked whether there will be different variants of



AMD Radeon
Fury X with
cooler.

the Fury X, given this “OC board” talk, I was told that there will only be one SKU, and it’s the usual “silicon lottery” when it comes to your GPU’s overclocking capabilities. (Overclocking capabilities vary from individual GPU to individual GPU; another Fury X could have much more headroom than ours, for example.)

All that said, we’ve heard through the grapevine that we’re not the only ones experiencing disappointing overlocks with the Fury X, either. So if you’re considering picking up a Fury X, peruse the following gaming benchmarks knowing that you may not be able to eke out additional performance via overclocking.

AMD Radeon R9 Fury X gaming benchmarks

Enough preamble! Let’s dive into the nitty-gritty.

As with all of our graphics card reviews, I benchmarked the Radeon R9 Fury X on PCWorld’s GPU testing system, which contains:

- > Intel’s Core i7-5960X with a Corsair Hydro Series H100i closed-loop water cooler, to eliminate any potential for CPU bottlenecks affecting graphical benchmarks
- > An Asus X99 Deluxe motherboard
- > Corsair’s Vengeance LPX DDR4 memory, Obsidian 750D full tower case, and 1200-watt AX1200i power supply
- > A 480GB Intel 730 series SSD
- > Windows 8.1 Pro

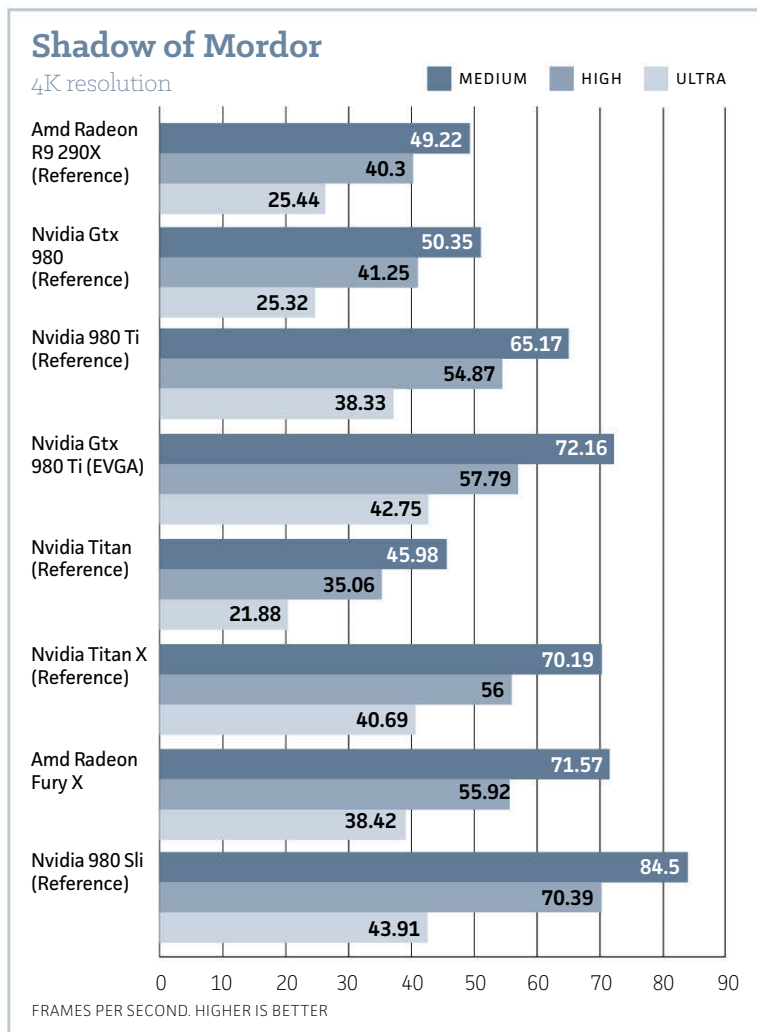
As far as the games go, we used the in-game benchmarks provided with each, utilizing the stock graphics settings mentioned unless otherwise noted. We focused on 4K gaming results for this review.

I’ve compared the Fury X against Nvidia’s reference GeForce 980 Ti, GeForce 980, and the \$1,000 Titan X, as well as AMD’s older Radeon R9 290X and the Radeon R9 295x2, which packs two of the Hawaii GPUs found in the R9 290X. I’ve also included benchmarks from a card that we don’t yet have a formal review for: EVGA’s \$680 GeForce GTX 980 Ti Superclocked+ (aka the GTX 980 Ti SC+), an aftermarket version of the GTX 980 Ti that sports EVGA’s popular ACX 2.0+ dual-fan cooling system.

EVGA sent me the GTX 980 Ti SC+ on the same day AMD passed me

the Fury X—pure coincidence, I'm sure.

Let's kick things off with *Middle-earth: Shadow of Mordor*. This nifty little game gobbled down tons of industry awards and, more importantly for our purpose, offers an optional Ultra HD textures pack



that is only recommended for cards with 6GB or more of on-board memory. That doesn't hinder the Fury X's ability to come out swinging with slightly higher frame rates than the reference GeForce GTX 980 Ti—no small feat, especially when the game opens with a splash page championing Nvidia technology.

The game was tested at Medium and High quality graphics presets, then by using the Ultra HD Texture pack and manually cranking every graphics option to its highest available setting, which *Shadow of Mordor*'s Ultra setting doesn't actually do. The R9 295x2 consistently crashes every time I attempt to change Mordor's resolution or graphics settings, hence the zero scores. (Ah, the joys of multi-GPU setups.)

Sleeping Dogs: Definitive Edition absolutely murders graphics cards when the graphics settings are set to Extreme at high resolutions. Only the dual-GPU Radeon R9 295x2 hits 30 fps at 4K resolution, though the Fury X hangs with its Nvidia counterparts. You can view detailed results of our tests at: go.pcworld.com/furyxbench.

The Fury X also hangs tight with the reference GTX 980 Ti in *Metro Last Light Redux*, which we test with PhysX and the frame rate-killing SSAA options disabled. EVGA's version of the GTX 980 Ti trumps all single-GPU comers, though the dual-GPU Radeon R9 295x2 fires on all cylinders in this title.

The Fury X and reference 980 Ti are neck and neck in *Alien Isolation*, a game that scales well across all hardware types and falls under AMD's Gaming Evolved brand.

The gorgeous *Dragon Age: Inquisition* also partnered with AMD at its launch, but Nvidia's cards maintain a clear lead. Note that the R9 295x2 apparently doesn't have a working CrossFire profile for the game, so it drops down to using a single GPU.

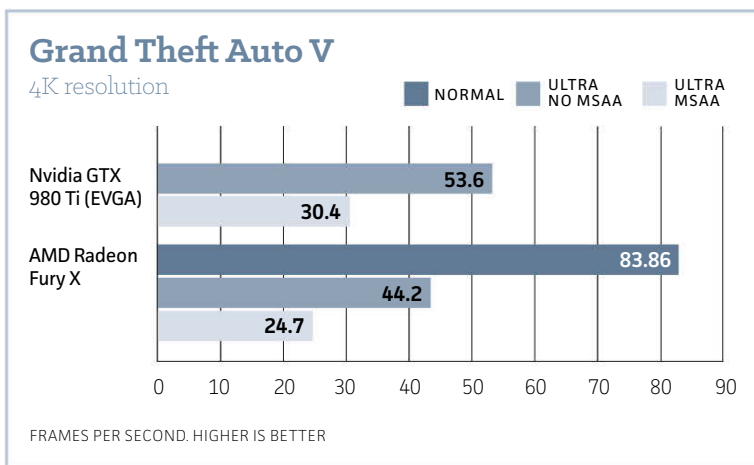


AMD Radeon
Fury X with
split view.

The same goes for *Sniper Elite 3*. Note that we didn't have a chance to test the reference GTX 980 Ti here.

We also tested the Fury X and EVGA's 980 Ti Superclocked+ in *Grand Theft Auto V*, because the game is notorious for demanding more than 4GB of memory—HBM's top capacity—at high resolutions.

We tested the game three ways at 4K resolution. First, by cranking all the sliders and graphics settings to their highest settings, then enabling 4X MSAA and 4X reflections MSAA in order to hit , of RAM usage; then, using the same settings but disabling all MSAA to drop the memory usage to 4,029MB, just under the Fury X's limit; and then by testing the Fury X's chops at normal graphics settings with MSAA disabled, which consumes 1,985MB of memory. (We didn't have time to benchmark any other cards, alas.)

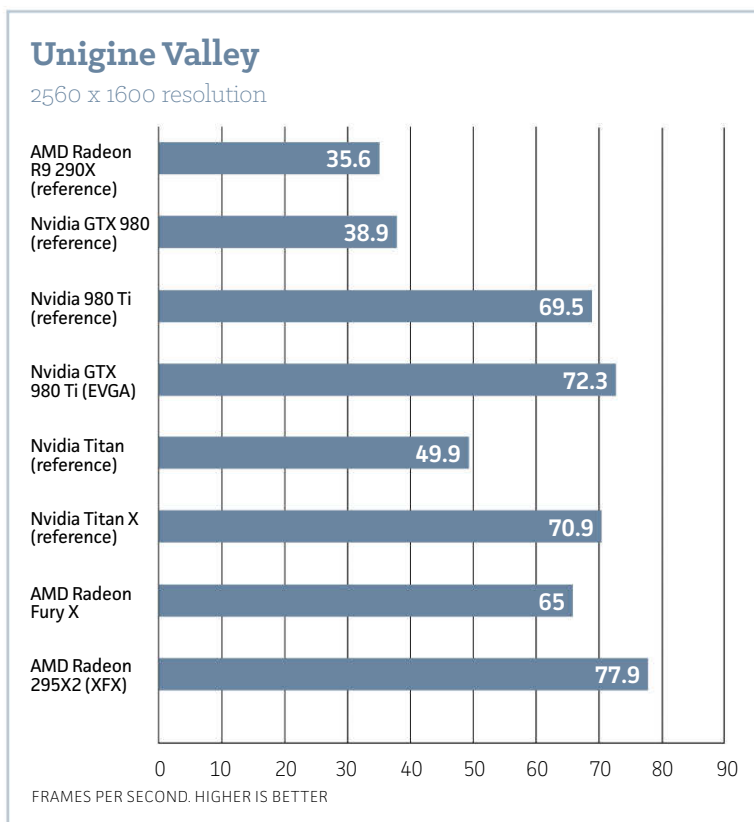


The EVGA card pounds the Fury X here—no wonder *GTA V* wasn't included in the reviewer's guide benchmarks AMD provided for the Fury X. But the frame rate averages alone don't show the full experience: When *GTA V* was pushed to consume more memory than the Fury X has on board, the experience became extremely stuttery, choppy, and graphically glitchy as the card offloaded duties to system

memory, which is far slower than HBM.

That's to be expected when a game's memory use exceeds the on-board capabilities of a graphics card, however, which was a big part of the reason gamers were in such a tizzy over the GTX 970's segmented memory setup earlier this year, in which the last 0.5GB of the card's 4GB of RAM performs much slower than the rest.

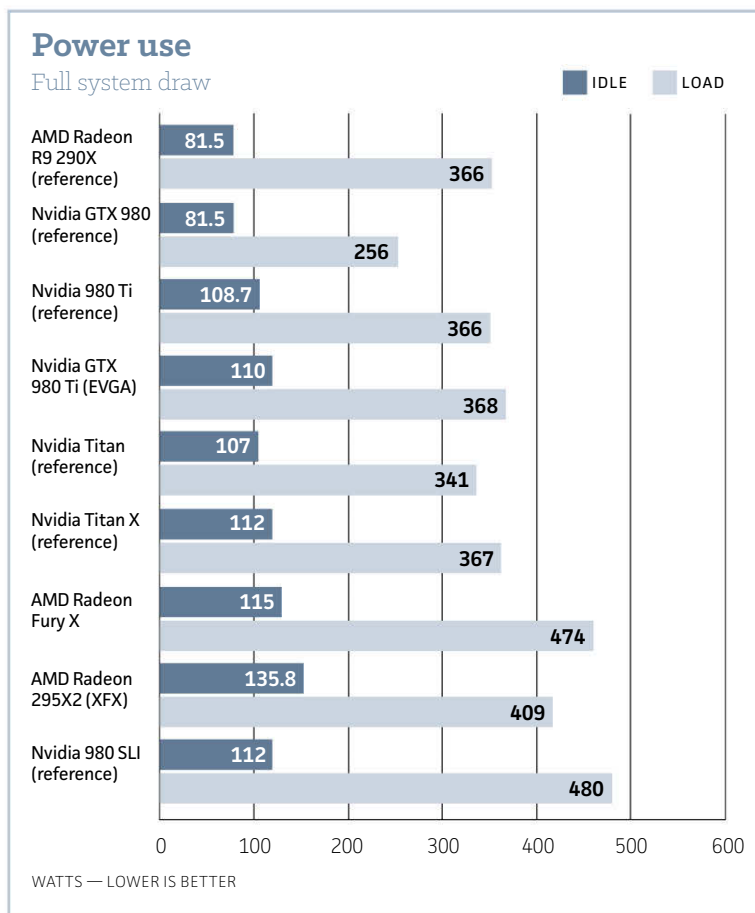
I also tested the systems using three synthetic, but well-respected benchmarking tools: 3DMark's Fire Strike and Fire Strike Ultra, as well as Unigine's Valley. As AMD promised, the Fury X comes out ahead of the reference GTX 980 Ti in Fire Strike and Fire Strike Ultra, beating even the EVGA variant at the former, perhaps due to HBM's speed—



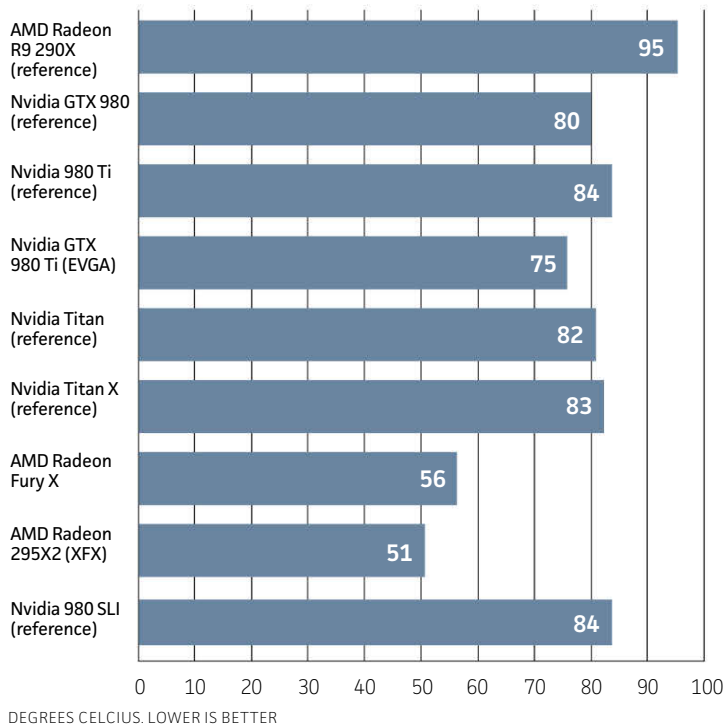
though the tables are turned in the Valley results. (See Fire Strike and Fire Strike Ultra test result charts at: go.pcworld.com/furyxbench.)

To test power and thermal information, I run the grueling Furmark benchmark for 15 minutes, taking temperature information at the end using Furmark's built-in tool and double-checking it with SpeedFan. Power is measured on a whole-system basis, instead of the GPU alone, by plugging the PC into a Watts Up meter rather than the wall socket.

As you can see, the Fury X may technically need only 275W for what



Maximum GPU temperature under load



AMD calls “typical gaming scenarios” but it draws much, much more under Furmark’s worst-case scenario—nearly as much as two GTX 980s (not Ti’s) in SLI. It drew even more power than the dual-GPU Radeon 295x2.

On the positive side, the Fury X runs extremely cool, hitting 56 degrees Celsius max after several hours of overclocking. There would be plenty of room for overclocking... if the chip itself overclocked worth a damn.

Bottom line

So there you have it: Between the new Fiji GPU and the inclusion of HBM,

AMD's Radeon R9 Fury X enters the rarefied air of single-GPU cards capable enough to play games at 4K resolutions with high graphics detail settings enabled—an exclusive club containing only it, the GTX 980 Ti, and the Titan X. (Like the Titan X and 980 Ti, the Fury X struggles to hit a full 60fps at 4K/high, however, so if you opt to pick one up you should consider picking up a new 4K FreeSync monitor to go with it.)


One more time: The Fury X kicks ass! Both technically and aesthetically. AMD needed a hit, and the Fury X is sure to be one with Team Red enthusiasts.

That said, it's hard not to feel a bit disappointed about some aspects of the card—though that may have to do more with AMD's failure to manage expectations for it.

After hearing about HBM's lofty technical numbers for months, it's disappointing to see little to no pure gaming benefits from all that bandwidth. After seeing the tech specs and hearing AMD's Joe Macri wax poetic about the Fury X's overclocking potential, it's majorly disappointing to see it fail so hard on that front, crappy silicon lottery draw or no. And while 6GB of RAM is still overkill for the vast majority of today's games, it's disappointing to see the Fury X limited to just 4GB of capacity when some of today's games are starting to blow through that at the 4K resolution that AMD's new flagship is designed for, as evidenced by our GTA V results.

The timely arrival of EVGA's custom GTX 980 Ti, which beats both AMD and Nvidia's reference flagships in raw benchmarks, also takes some of the wind out of the Fury X's sails—wind that can't be countered by AMD's own hardware partners, because the Fury X is limited to reference designs alone.

No, the Fury X isn't the Titan-killer that Team Red fans hoped it would be—but it is a GTX 980 Ti equal. This is nothing short of a powerful, thoughtful graphics card that once again puts AMD Radeon on equal footing with Nvidia's gaming finest. Being one of the most powerful graphics cards ever created is nothing to sneeze at, especially when AMD wrapped it all up in such a lovingly designed package.

AMD's Radeon R9 Fury X kicks ass...even if it doesn't make Nvidia's high-end offerings obsolete. 



Tested: AMD's Frame Rate Target Control delivers real benefits for Radeon gamers

BY JASON EVANGELHO

FOR YEARS, AMD has prioritized raw graphics processing horsepower over things like power efficiency and quieter operation. Then Nvidia's Maxwell architecture came along and proved that video cards could dominate the benchmarks while still sipping power. With the launch of the new Radeon Fury X and Radeon R300 series, AMD has responded to community criticism and competitive heat with Frame Rate Targeting Control, a meaningful feature that has a serious

impact on daily gaming sessions.

Frame Rate Target Control (FRTC) is a new option in AMD's Catalyst Control Center that lets you set a maximum frame rate between 55 frames per second and 95 frames per second (fps) for the majority of DirectX 10 and DirectX 11 games. The message from AMD is that FRTC is a triple threat of benefits: You'll dramatically reduce your video card's power consumption, decrease fan noise, and lower the operating temps of your GPU.

Obviously we had to put those claims to the test.

Why AMD's Frame Rate Targeting Control exists

Wait, back up. Why on Gaben's green earth would we PC gamers—who are addicted to stunning eye candy and smooth-as-silk frame rates—want to limit our fps? Well, there are a ton of games out there that hit super-high frame rates on modern video cards. Your PC is effectively throwing them away and needlessly taxing your video card on three fronts: Power, noise, and temperature. This wasteful behavior prompted AMD to design FRTC.

Saving a few bucks on your power bill is likely lower on the priority list, but the dog days of summer and scorching GPU temperatures don't mix. Less heat on your card means less stress, and less stress means a longer, healthier lifespan for your hardware. Plus, a reduction in noise output from our video cards mean more immersion in our games.

The need for FRTC made itself abundantly clear when I booted up *Civilization: Beyond Earth* and noticed that literally thousands of frames were being wasted in the menus. Per second. Being a fairly lightweight game, my fps spiked north of 2,000 inside the menus. I was reasonably



The Frame Rate
Target Control
options in AMD's
Catalyst Control
Center.

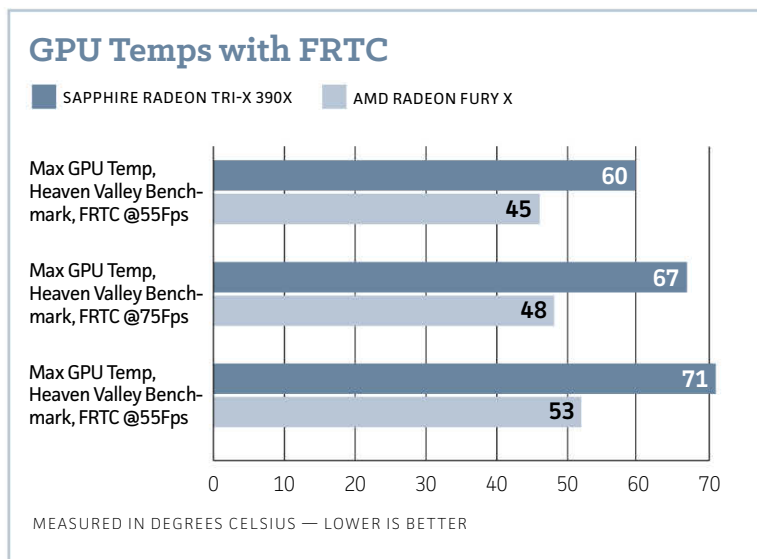
startled when I discovered how much needless electricity that was consuming, and the difference it made to GPU temperature and overall noise.

Even during normal gameplay, though, the advent of AMD's FreeSync (go.pcworld.com/amdfreesync) has reduced the need for insanely high frame rates. The bottom line: Constraining your frame rate often has a negligible impact on the overall gameplay experience, and as you'll see in a minute, the benefits to doing so might be worth pursuing.

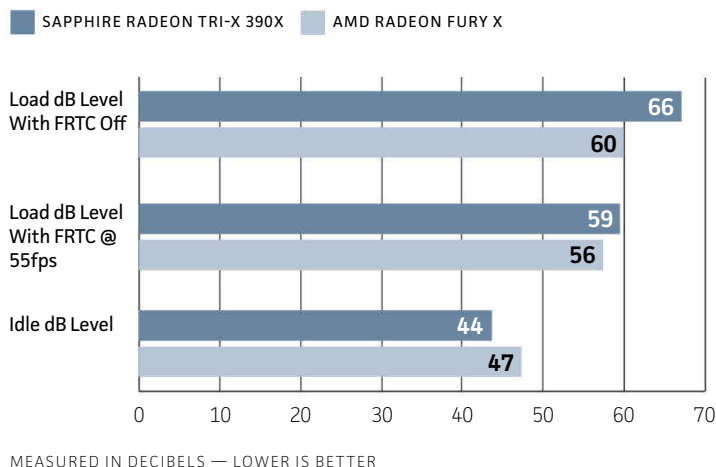
Frame Rate Targeting Control tested

We rounded up AMD's new flagship Radeon Fury X and a Sapphire Tri-X Radeon 390x to observe FRTC's impact on both liquid-cooled and traditional air-cooled video cards. We then fired up *Dirt Rally*, *BioShock Infinite*, and *Civilization: Beyond Earth* at 1440p and measured minimum and maximum system power draw levels with FRTC off, capped at 55 fps, and capped at 75 fps.

To get a good bead on any noise level and GPU temperature



Peak Noise with AMD framerate targeting control



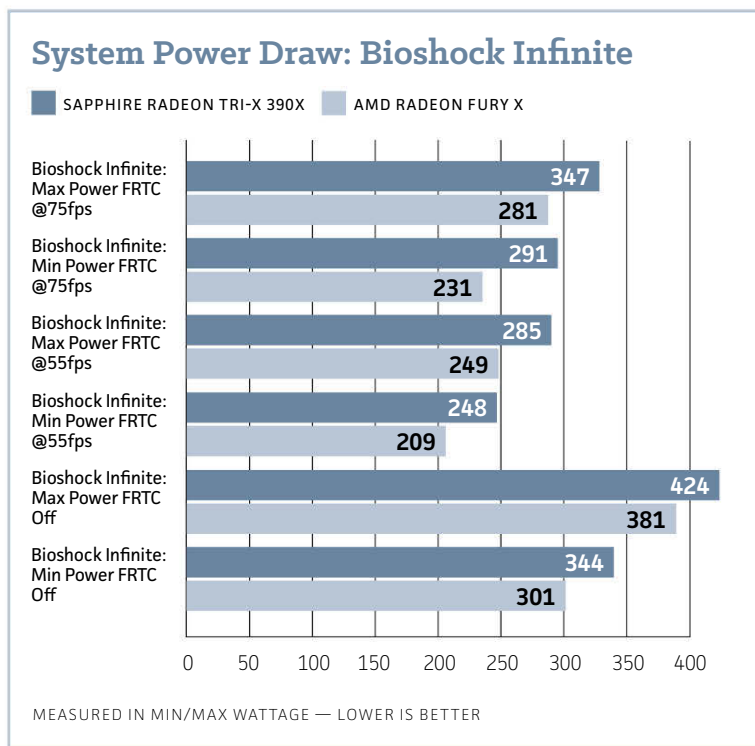
improvements, we ran the Heaven Valley benchmark in 15-minute loops and took note of peak decibel levels and temps under load once the cards were nice and warmed up.

With FRTC off and Heaven Valley set to Medium quality at 1440p, frame rates ranged from 75 fps all the way up to 120 fps, depending on scene complexity. What happens when we put a leash on those frames? The already-cool Fury X sees a 15-percent temperature reduction, and Sapphire's air-cooled 390x reaps the identical benefit, dropping from 71 degrees Celsius down to 60 degrees Celsius.

No one enjoys a noisy graphics card whirring away in their chassis, which is why it's awesome to see that FRTC has notable influence over noise levels. Sapphire's 390x starts off reasonably quiet, but with FRTC capped at 55 fps (currently the lowest setting possible), it dives from 66dB to 59dB. On the surface that might seem inconsequential, but decibels are measured in increasing magnitudes of intensity. This translates to a card that isn't merely 7dB quieter—it's 1.6x quieter.

So how about AMD's power consumption claim? Does trimming the frame-rate fat really result in less system power pulled from the wall? It does indeed.

Take a look at that *BioShock Infinite* chart, especially the Fury X results. It's a power hog with its frame rate left unencumbered (in the low to mid 100s). The minimum amount of power drawn from the wall while running with FRTC off is higher than the maximum power draw with FRTC set to 55 fps. All told, it's a healthy 34 percent reduction in wattage at the wall. Other high-frame-rate titles like *Civilization: Beyond Earth* and *Dirt Rally* exhibit similar—if a bit more minor—energy savings.




Bottom line

So with a simple Catalyst Control Center tweak that taps into Radeon 300 series graphics cards and AMD's Fury lineup, we see a meaningful set of benefits. AMD's Frame Rate Target Control makes your PC gaming sessions more enjoyable by turning down the ambient volume, dropping the degrees, saving you a few bucks at the wall, and likely extending the life of your video card by removing some unnecessary stress.

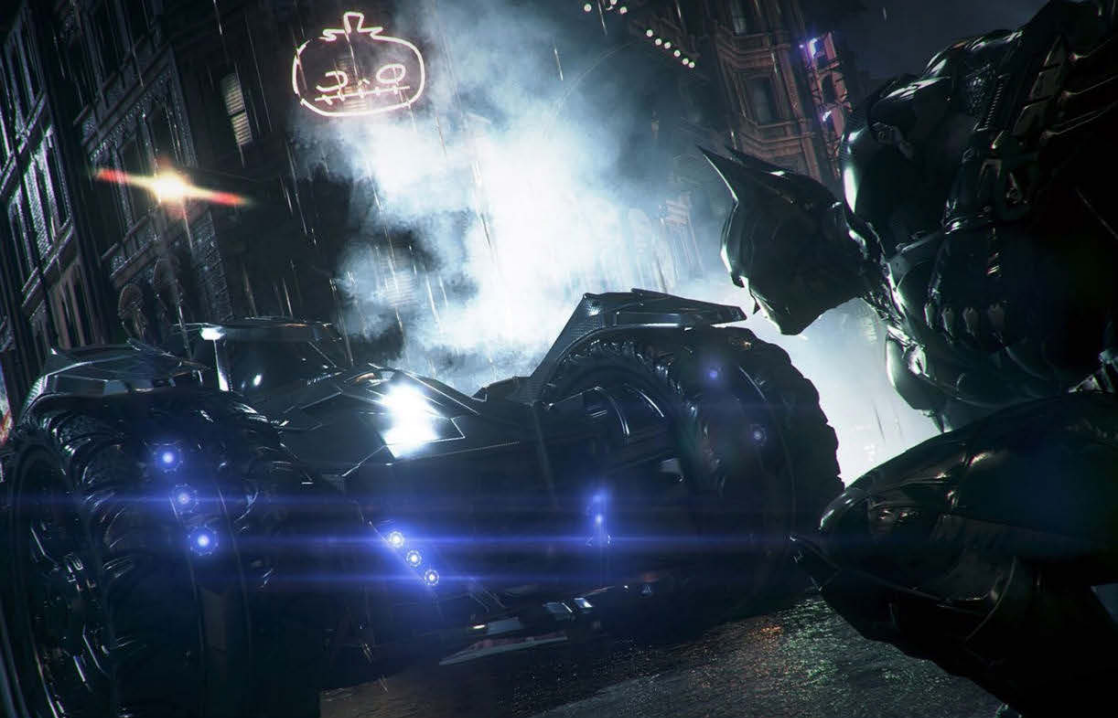
There's one minor quibble worth pointing out. Originally we wanted to test Blizzard's *Heroes of the Storm*, but found that FRTC

had no effect on it. We then bounced over to *Diablo III*, and FRTC was once again ineffective. At this point we suspect it's a glitch with Battle.net titles, at the very least within our test environment. An inquiry to AMD has gone unanswered as of this writing.

That said, we've been impressed with Frame Rate Target Control. The experience is augmented even further when you incorporate one of AMD's FreeSync panels, which allows your display to dynamically sync its refresh rate with your GPU, eliminating screen tearing and input lag from the equation. But with or without FreeSync, FRTC is a very welcome new feature in AMD's software ecosystem.

Update: After our tests were completed, AMD released Catalyst 15.7 WHQL (go.pcworld.com/amdcatalyst157) drivers which extended both FRTC and AMD's virtual super resolution to the vast majority of Radeon R200-series and Radeon R00-series graphics cards, as well. 

We've been impressed with Frame Rate Target Control while thoroughly testing it over the past few days.



Batman: Arkham Knight: How bad are the issues? Pretty bad.

BY GORDON MAH UNG

AFTER PLAYING THE *Batman: Arkham Knight* game on several PCs, it's obvious why WB Games decided to suspend sales.

PC gamers, we should have expected this.

Despite this year being *our* year, with our own dedicated PC-gaming show at E3, *Batman: Arkham Knight* (batmanarkhamknight.com) is an unkindly reminder of where we stand with game developers: Console gamers got a brilliantly crafted game while we're stuck with a standard-issue, glitch-filled port.

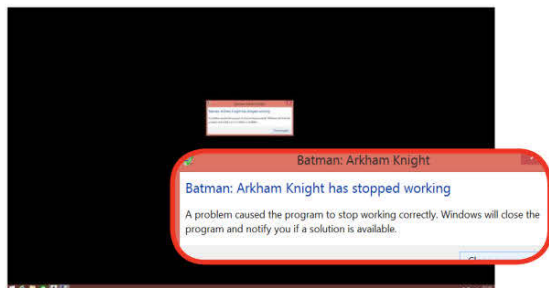
At least that's what nearly 8,000 and counting people on Steam are saying about this brand-new game. The torches and pitchforks became numerous enough that WB Games made the nearly

unprecedented decision to indefinitely suspended sales of the PC version of *Arkham Knight* until its problems can be resolved.

As one of the hottest games of the season, *Batman: Arkham Knight* had big marketing dollars behind it and a strong Metacritic score of 89 filling its sails. Every one of those critics, however, reviewed the PlayStation 4 version. No reviews of the PC port were published before the game was shipped.

With thousands of people who purchased the PC version filing complaints about texture flashing, crashing, stuttering, and terrible frame rates, *Batman: Arkham Knight* is what's technically called a hot stinking mess.

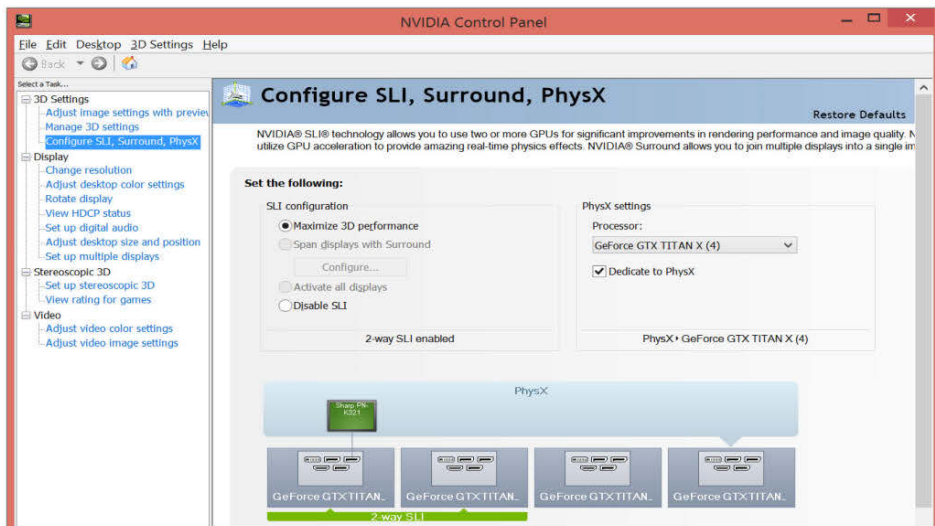
To find out just how bad it was, I fired up *Batman: Arkham Knight* on the most powerful gaming PC I had on hand: a 4-way SLI GeForce Titan



Want to know what *Batman: Arkham Knight* looks like with 4-way Titan X in SLI and a Core i7-5960X overclocked to 4.5GHz? This 4K resolution error message.



Watch the video at
go.pcworld.com/arkhamknightvid



X rig with a Core i7-5960X overclocked to 4.5GHz, RAIDed SSDs, and 16GB of DDR4/2666 RAM. What does \$11,000 worth of fire-breathing, meat-eating metal get you? How about 30 frames per second? (*Insert needle-scratch sound.*)

And no, that's not at surround 4K or straightforward 4K resolution. WB Games decided to lock Arkham Knight down to 30 fps no matter *what* hardware you're running. Whether it's a GeForce GTX 960 or a four-way GeForce Titan X setup, this game will max out at 30 frames per second running on a PC.

The good news is there's a workaround, but you'll need to dig into an INI file rather than, oh, use an in-game switch.

Backup your game first, and then dig into C:\ProgramFiles(x86)\Steam\steamapps\common\Batman Arkham Knight\BMGame\Config, and then open BmSystemSettings.ini in Notepad and look for the line that says MaxFPS=30.000000. Changing that to either 60 or 120 will allow the game to run at higher frame rates.

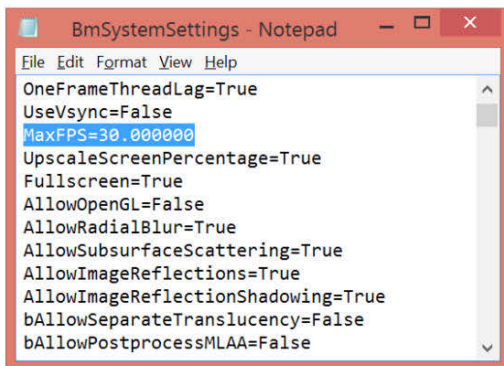
Setting PhysX

to run on GPU number four would at least get the game to run for me.

But then there's crashing too

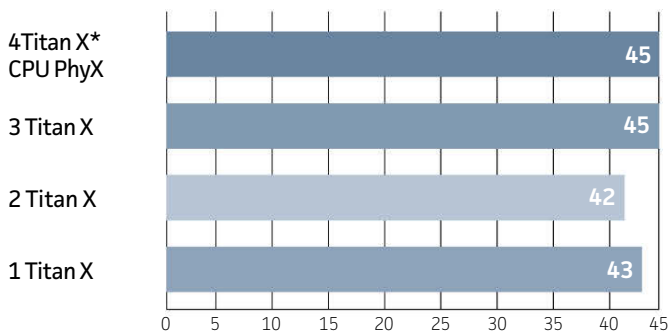
On my 4-way system, I initially ran the game at 1080p to see if issues would crop up; but once I'd changed that .INI file, I decided to let it run in its full 4K glory: I was immediately greeted with the game crashing as soon as I tried to run it in benchmark mode. After that crash, it never went back to working without mucking around. Even setting the .INI file back to a maximum of 30 fps didn't help.

Through this mucking around, I determined that the only way to get it to run was to follow WB Games' advice (go.pcworld.com/arkhampcupdate) to dedicate one of my GPUs to PhysX to help "performance." It didn't help performance in my experience, but it at



You can override the 30 fps lock in *Batman: Arkham Knight* by editing one of its .INI files.

Batman: Arkham Knight 4K performance



LONGER BARS INDICATE HIGHER PERFORMANCE

What's wrong with this picture? We don't know, and maybe that's why WB Games pulled the PC version of *Batman: Arkham Knight*.

least made it so I could play the game. All of my issues, mind you, were with the recommended Nvidia 353.30 GameReady driver that technically supports SLI. More on this later.

Letting the Nvidia driver automatically select the GPU to run PhysX on would cause a crash. And in the bizarre column, depending on which GPU you ran, PhysX would limit your SLI support. Run PhysX on GPU number one or two and you get no SLI support whatsoever. Run it on GPU number four and you get SLI or two GPU's only. Running it on GPU number three though, would get you tri-SLI at least, with only occasional crashes to the desktop.

One reliable way I could get the game to run on all four GPUs, at least according to the Nvidia control panel, was to run PhysX on the CPU. But that turned off the game's Interactive Smoke and Paper Debris settings. And as controversial as GameWorks and PhysX are to gamers who run AMD video cards, the effects in *Batman: Arkham Knight* are beautiful.

It's only after seeing *Batman: Arkham Knight* with the smoke and paper effects on and off that you realize what you're missing. It's almost enough to make someone who doesn't like proprietary technology forgive the game for using those Nvidia-only features. I mean, that smoke is *wondrous*. Watch the video and you can see it curl as the Batmobile peels down the street.

The game's performance is another head-scratcher. Let me remind



The smoke in this scene looks dramatically better with GameWorks fog and paper effects and PhysX enabled.



You can love or hate GameWorks, but having the smoke effects turned off makes the Batmobile's burnout look wimpy. This would get you negative feedback at an Oakland sideshow.

you, I'm running the game on an 8-core Core-i7 rig with four water-cooled Titan X cards. This rig pushes *Middle-earth: Shadow of Mordor*, with its HD textures at 4K resolution, at 100 fps. It plays *Tomb Raider* at 4K on Ultimate at nearly 170 fps. With *Batman Arkham Knight*, the in-game benchmark reported a dismally low frame rate in the 40's. Even crazier, I wasn't seeing any SLI scaling at all. One Titan X, two Titan X, or four didn't move the needle. *All* of my performance tests were in the mid- to low 40s. I tried the latest GeForce Experience optimizations and multiple reboots with nary a difference.

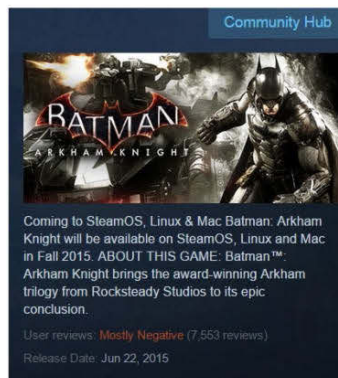
What's up? I spoke with Nvidia officials who said they're trying to figure out what my problem is, because they are seeing scaling internally. I'll report back once we figure it out.

What about AMD?

Remember, this is the game running on Nvidia hardware, which traditionally has a leg up in performance and stability over AMD GPUs for this franchise. Many AMD users have also reported issues running the game. Even worse, the section of WB Games' FAQ that discusses running the game on both AMD and Nvidia hardware reads like the fine print for a prescription drug that hasn't yet passed FDA trials.

The craziest part of *Batman: Arkham Knight* is that when it *does* run, it seems to run fine. In addition to running it on that Big Bertha Titan X system, I also ran it on Asus' new ROG gaming laptop, which is outfitted with a GeForce GTX 980M. It ran just fine, with frame rates on the single card in the 60 fps range. That's at 1080p resolution, mind you, but it makes it even more puzzling that the game ran so poorly on a desktop PC with a single Titan X.

Bottom line: WB Games made the right move in suspending sales. 🚫





Batman: Arkham Knight (PC): Holy squandered potential, Batman

BY HAYDEN DINGMAN

UP FRONT: THERE are going to be spoilers in this review. Or, at least, a few of you may deem them spoilers—I am going to actively discuss *some* of the villains in *Arkham Knight*. By name. And a few of the plot points. Why? Because there are very specific examples that I feel embody *Arkham Knight*'s failings, and it's easier for me to just talk through them than talk around them.

Good? Good. Let's dig in.

Na-na-na-na-na-na-na-na-na

Phew. Where to even start with *Arkham Knight*? I mean, we could take the easy route on this one and talk about how busted the PC port is. It is *busted*. I got a higher frame rate in *The Witcher 3* on Ultra than I did in *Arkham Knight*, and I don't just mean because of the console-esque, 30-frames-per-second cap the game shipped with.

You know what though? The PC version will get fixed. It might take weeks. It might take months. But I have no doubt eventually Rocksteady will fix it. Should it have been released this way in the first place? Absolutely not, and thus we're not bothering to score this review. It is not a game in any condition to be scored. And, for that matter, it's not even on sale anymore.

The technical problems with *Arkham Knight* have been a lightning rod, though. There are so many other issues with this game that have





nothing to do with its frame rate, its textures, any of that. Let's discuss those instead.

Sure, it's fun, but *Arkham Knight* is not a great game. It is a collection of pretty great mechanics soldered onto some cringe-worthy dialogue, a pile of meaningless side missions, a decent main story, some truly illogical plot conceits, and so much forced vehicular action it'd be easy to forget this is a story about Batman.

Everything that is great about *Arkham Knight* has been lifted from Rocksteady's previous two games—the incredible *Arkham Asylum* and the slightly-less-incredible-but-still-good *Arkham City*. Embodying Batman in *Arkham Knight* is, frankly, fantastic. The trademark Batman combat has never been more fluid. Gliding around the city is considerably less janky than it was in *Arkham City*. And there's a new move that involves ejecting out of the Batmobile at high speed and launching yourself a mile into the air before gliding around Gotham. It looks *badass*.

That is the last nice thing I am going to say about the Batmobile. See, the Batmobile is problem number one with *Arkham Knight*.

Everything that is great about 'Arkham Knight' has been lifted from Rocksteady's previous two games.

Rocksteady touted the Batmobile feature a ton prior to release, and now we know why: because it's been forced into practically every single encounter in the game. Even Riddler's missions. Riddler now constructs race tracks. No, I am not joking.

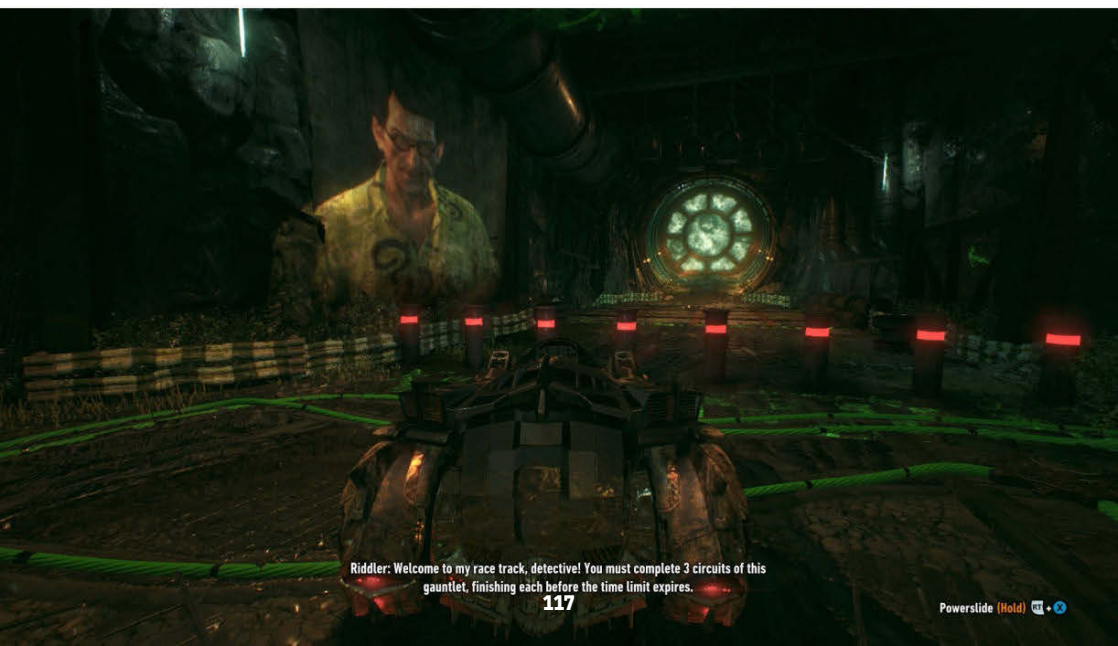
There are a few issues here. First of all, *THE RIDDLER NOW CONSTRUCTS RACE TRACKS*. This is something so magnificently stupid I can't even fully come to grips with it.

Other missions have you fighting legions and legions of "drones"—they're tanks but they're unmanned because Batman doesn't kill!—until your eyes glaze over. None of these missions are particularly hard. Just tedious.

But the greatest sin of the Batmobile has nothing to do with the car itself. Rather, it's the design direction the game took once it was apparently mandated that Batman's biggest and most inefficient gadget had to factor into practically every part of the game.

One of the best ideas in *Arkham Asylum* and *Arkham City* was something I'll refer to as the "Villain Lair." In *Asylum*, this

Riddler now
constructs
race tracks?!



Riddler: Welcome to my race track, detective! You must complete 3 circuits of this gauntlet, finishing each before the time limit expires.



**Here is
Penguin's** big
lair. Looks...not
very Penguin-y.

meant seeing how each member of Batman's Rogues Gallery transformed their little section of Arkham—a fiefdom within Joker's larger kingdom. *Arkham City* kept the same idea, except it expanded to villains' owning entire buildings. "Here's Penguin, holed up in a weird museum! Here's the (infamous) Mr. Freeze section! Here's Mad Hatter's lair of Scarecrow-inspired dream sequences!"

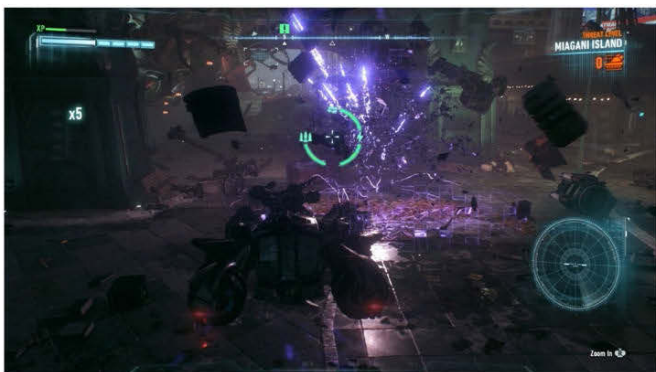
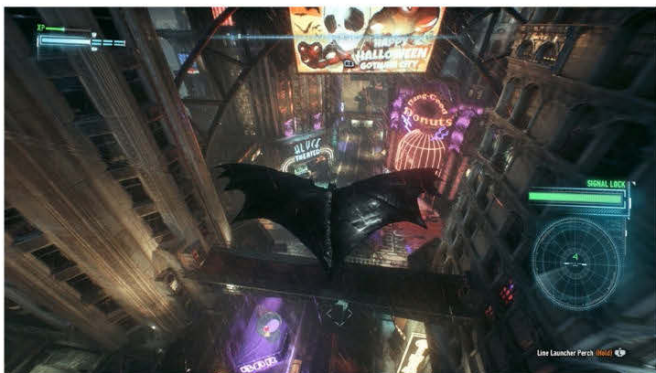
Arkham Knight abandons this and squanders its villains, especially outside of the main story. Penguin is smuggling guns out of featureless warehouses. Firefly pulls the same "bust out of a building that's on fire" move *three times* before deciding he's been punched in the face enough to stay down. Man-Bat doesn't even do *anything*—he just flies in circles until you decide to find him. Two-Face is robbing generic banks.

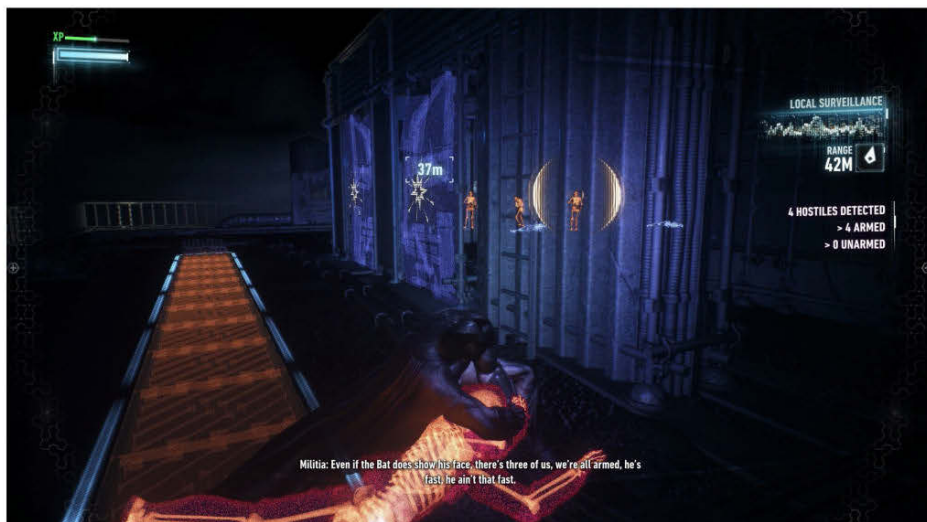
And Deathstroke—oh, poor Deathstroke. He doesn't even get his own unique story line. One of the most fearsome villains in the DC Universe is relegated to a fourth-tier role here, as he takes over for *another* villain you've already confronted. Even worse? Deathstroke's "boss battle" is a Batmobile-led tank battle that's literally a copy-paste of a tank battle you already played earlier in the game.

Batman's most iconic villains are just sort of... doing nothing at all. Farting around committing petty crimes while the entire city is on the verge of extinction. God forbid Two-Face rob a few banks while Scarecrow is threatening to *literally wipe Gotham off the face of the planet with fear toxin*.

It feels empty. Tedious, even. And how did we get here? The other *Arkham* games somehow managed to make even lame characters (Calendar Man) seem interesting, or like you should know something about them. Here, even the franchise's most iconic characters come off as buffoons (at worst) or just empty filler characters (at best). There's nothing uniquely Penguin about smuggling guns, nothing uniquely Two-Face about robbing banks. And by placing them in these settings, you also miss out on the whole "Lair" aspect. Your final fight against Two-Face takes place in a bank that's indistinguishable from the first two he robbed. There's nothing there that screams "Two-Face." No clever environmental storytelling.

Which is weird because the city of Gotham itself is just as over-the-top as it was in *Arkham City*. There's neon everywhere. All the buildings teem with unique art and visual design. It's a creative, comic book-esque take on the city and I love flying around it—but very few of





these buildings actually factor into the story in any interesting way. They're just there to look pretty while you glide/drive around.

And I blame it on the Batmobile. I do. *Arkham City* had the same open-world setup as *Arkham Knight*, but it played completely differently. The city was essentially an enormous hub between the actual levels. Very little of the game took place in the city itself. Instead, you flew to wherever the next mission was, *went inside*, and then explored the building often for upwards of half an hour.

Arkham Knight is so afraid of letting you be inside, because what if... what if you forget about the Batmobile? As such, probably 90 percent of the main story and 80 percent of the side missions take place in the city itself. And the rest? It's mostly made up of quick hit-and-run beats. Two-Face's robberies, for instance—you're only inside for five to ten minutes, max. Then you're kicked back onto the street.

The result is a game that feels unfocused, that feels like it's shuttling you from empty mission to empty mission and discarding all its villains. Whereas *Arkham City* felt like it had potentially too many villains, *Arkham Knight* feels like it has too few—or at least too few that

matter. It's basically Scarecrow (the main baddie) and the titular Arkham Knight. Everyone else is disposable.

Luckily Scarecrow carries some of the narrative weight, thanks to an excellent, truly wonderful performance by John Noble. Unfortunately, it's a *Star Wars* situation where you have a talented actor reading utter farce. On the other hand, he's so menacing you can forgive the occasional plot hole or telegraphed twist.

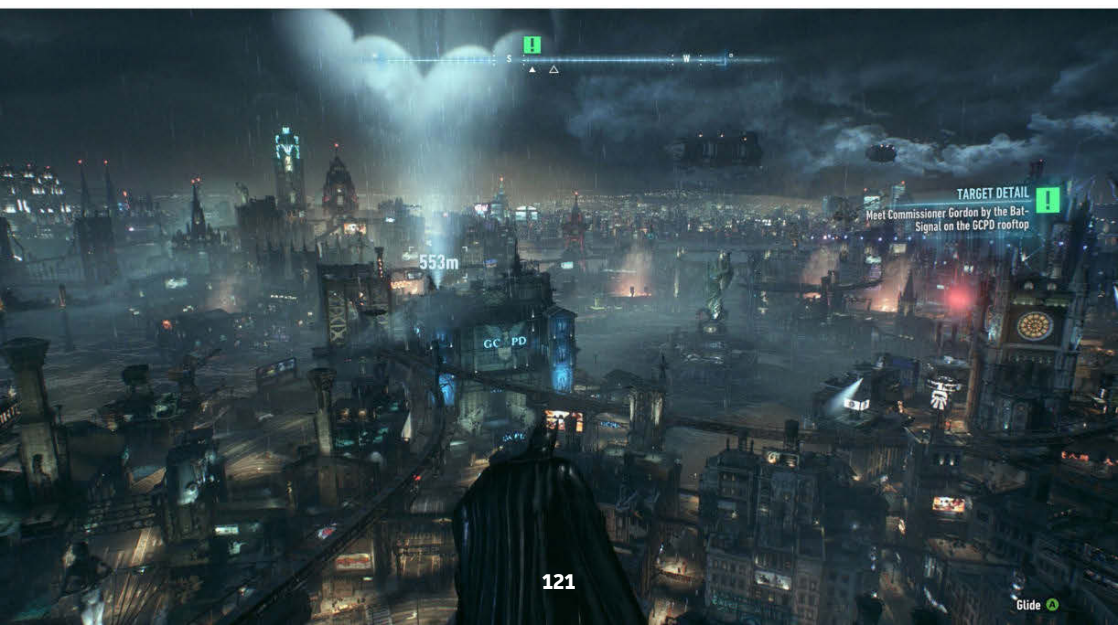
Sorry, when I said "occasional plot hole" I meant "*Arkham Knight's* plot is silly." Even with the spoiler tag above, I don't want to kill the *whole* plot for you.

But let's just say there's a point where Scarecrow announces his *big backup plan*...and it's to cover Gotham in fear toxin. A Gotham that's already been evacuated. A Gotham that is only populated by a handful of police, Batman, Alfred, and a whole bunch of villains.

Go ahead, Scarecrow. Gas the city. See if I care.

Bottom line

The thing about *Arkham Knight*, about reviewing *Arkham Knight*, is I didn't even hate the game. It's a summer blockbuster. It's soda and



popcorn. It's something that goes down smoothly (aside from the stupid tank sections), but at the end you've consumed nothing at all of value.

I'm not going to say that *Arkham Asylum* and *Arkham City* were particularly smart games, but they were smart *superhero* games. Take the grit of Nolan's Batman, combine it with the eye-candy of Tim Burton's Gotham, and you've got one hell of a take on the dark knight. The *Arkham* series was great because it played to Batman's strengths—his brutality, his knack for inducing fear, his cleverness, and (most importantly) the unique and twisted personalities of his villains.

Arkham Knight doesn't do those things. It doesn't let Batman be Batman. It doesn't let Batman's villains be villainous. With the exception of a *single plot thread* it squanders two games' worth of setup and replaces much of what I loved about the series with pointless filler. Filler I completed. Filler I even sometimes enjoyed on a purely mechanical level—crawling through vents and silently taking down henchmen as Batman is as satisfying as ever.

But too often I felt like *Arkham Knight* was a professional athlete post-retirement: Bloated, unfocused, and always boasting about a really nice car. 🔌





*“I want
to be
a bench.
Recycle me.”*



IWantToBeRecycled.org



KEEP AMERICA
BEAUTIFUL

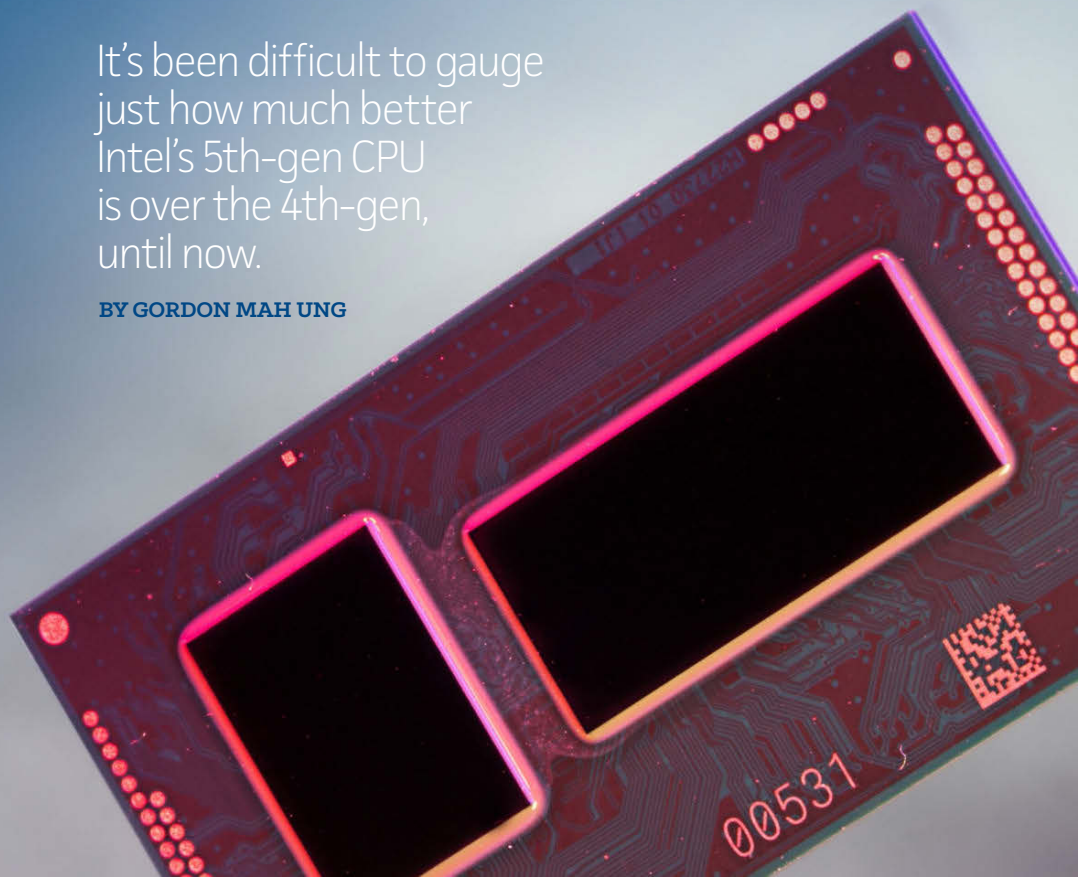
THE TRUTH ABOUT INTEL'S **BROADWELL**

VS.

HASWELL CPU

It's been difficult to gauge just how much better Intel's 5th-gen CPU is over the 4th-gen, until now.

BY GORDON MAH UNG



I NTEL'S FIFTH-GENERATION BROADWELL CPU has been the default laptop processor of choice since its debut in January, but it's been difficult to get a real bead on just how much of an improvement it was on its Haswell predecessor.

That's because unlike desktops, where it's easy to control the environment they run in, laptops are complete packages. I tried to compare the updated ThinkPad X1 Carbon with Broadwell to the Haswell ThinkPad Carbon X1, for instance, but it wasn't quite apples-to-apples. I initially determined that the Broadwell CPU was significantly faster than the Haswell. Something didn't ring right, though, and ultimately I decided Lenovo's redesign of the laptop likely contributed to the results and really made it useless to try to draw any conclusion on the CPUs themselves.

My second chance came when I found upon two laptops that were identical—save for the CPU. Dell's commercial Latitude E5250 at one point simultaneously shipped with Haswell and Broadwell parts.



The Dell Latitude E5250, at one point, came in both Haswell and Broadwell trim, making it perfect for testing.

THE COMPETITORS

The chips are very close. The Haswell-based E5250 uses an Intel Core i5-4310U, a dual-core chip with Hyper-Threading and a rated clock speed from 2GHz to 3GHz. The Broadwell-based E5250 has a Core i5-5200U that's also a dual-core with Hyper-Threading and ranges from 2.2GHz to 2.7GHz. While the Broadwell's base clock speed is a little higher, its top speed is a bit lower. Perhaps more importantly, both CPUs are also the same price.

For graphics, the Broadwell has Intel HD 5500, while the Haswell has Intel HD 4400 graphics. If you want to see more details of the two CPU competitors, I've lined them up at Intel's ARK site (go.pcworld.com/ark).

Everything else, from what I can tell, is the same. Both feature touch-panel, 1920 x 1080-resolution displays, 256GB Samsung mSATA PM851 mSATA drives, 8GB of DDR3L RAM in single-channel mode, the same 51-watt-hour capacity batteries, and the same Windows 8.1 OS. In fact, both even use the same motherboard, which I visually confirmed by opening up both E5250 laptops. The only difference in the motherboard is one has a Haswell soldered down to it, while the other has a Broadwell soldered down to it. This is no surprise: Intel designed the Broadwell to be "drop-in" compatible, and many makers did just that.

Single-threaded performance is very close—but surprise, the Haswell chip wins here.

THE TESTS

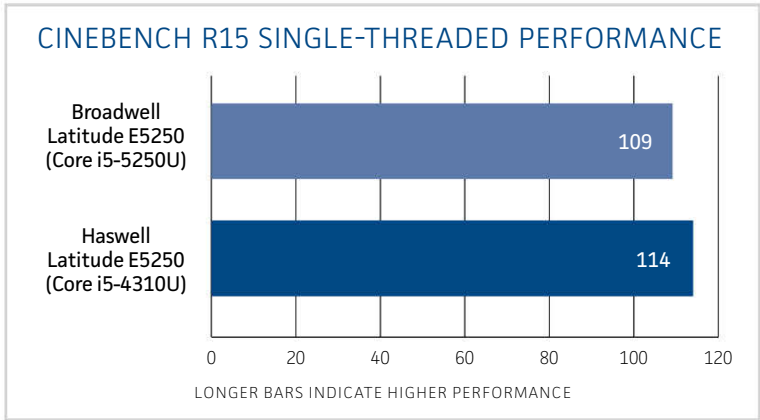
For benchmarks, I stuck with tests that would isolate the CPU performance as much as possible. First up is the pure CPU benchmark Cinebench R15, which measures a chip's performance rendering 3D. The performance, for the most part, is very close—but surprise, the Haswell chip actually wins here. I suspect that's because the single-threaded mode gives the Haswell chip a small advantage due to its higher clock speed when on Turbo Boost mode. The Broadwell tops out at 2.7GHz versus the 3GHz of the Haswell chip's top speed. That

gives the Haswell chip about a 10 percent clock speed advantage.

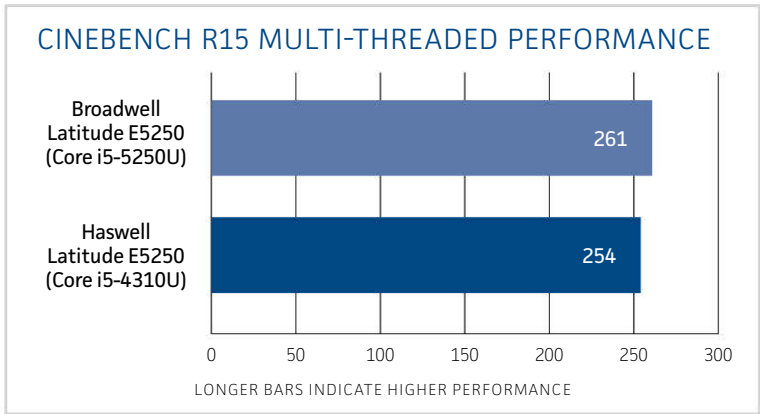
The good news for Broadwell is that its improvements in performance close the clock speed gap. Despite that roughly 10 percent clock speed difference between the two, the actual performance gap in Cinebench R15 is closer to 5 percent.

CINEBENCH 3D RENDERING PERFORMANCE

What happens when you run CineBench R15 in multi-threaded mode,

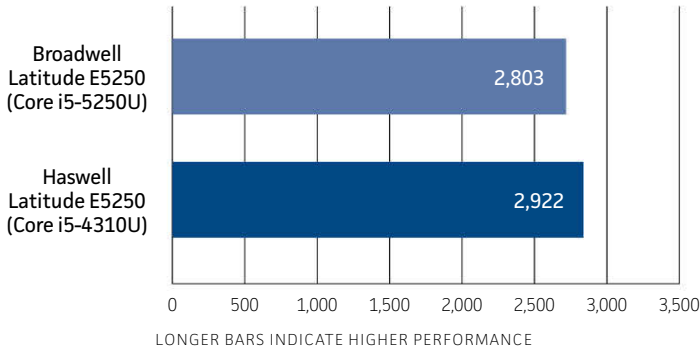


Cinebench R15 in single-threaded mode measures CPU performance and isolates just one core.



Despite being slower on single-threaded tasks than the Haswell chip, the Broadwell makes up for it in multi-threaded performance.

PCMARK WORK CONVENTIONAL



In general workloads, the higher clock speeds of the Haswell give it a slight advantage.

though, where it measures the overall performance of all the cores in a CPU? We see the Broadwell come back to edge out the Haswell chip. This is because, while the Broadwell chip is slower in overall clock speed when only one core is working, it runs a little cooler (thanks to its 14nm process). The Haswell has an advantage in the beginning, but as it heats up, it starts to throttle back on frequency so it's only about 100MHz faster by the end of the test. Combined with the better efficiency of Broadwell, it's just enough to make the 5th-gen chip barely faster here.

PCMARK 8 OFFICE PERFORMANCE

I also ran PCMark 8's Work test using the conventional setting. This keeps the workload to the CPU side instead of using a little of the graphics core for some tasks. PCMark 8 Work test is designed to simulate tasks such as videoconferencing and general-office droning.

PCMark 8's not heavily multi-threaded like CineBench and doesn't heat up the Haswell enough to make throttling a big problem. The Haswell CPU's slightly higher clock speed gives it the advantage here, but for the most part it's not enough to write home about. It's actually a fairly realistic evaluation of the low demands of mundane office tasks: The dual-core Haswell laptop scores 2,922. Consider that a

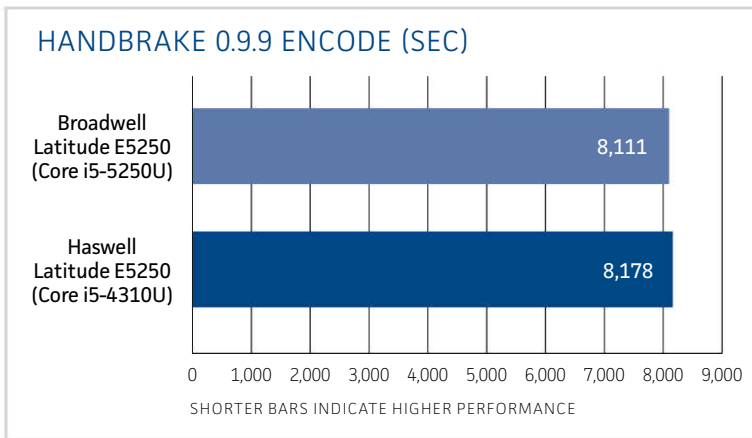
tested desktop (not shown here) with a six-core Core i7-5820K scored 3,321. That tells me PCMark 8's right on the mark for office tasks and you don't need that many cores for office work.

HANDBRAKE ENCODING PERFORMANCE

Looking for a heavier-duty task, I also threw in our standard encoding test, where we take a 30GB, 1080p MKV file and use Handbrake to transcode, using the Android for Tablet profile. On dual-core machines, it takes in excess of two hours to complete.

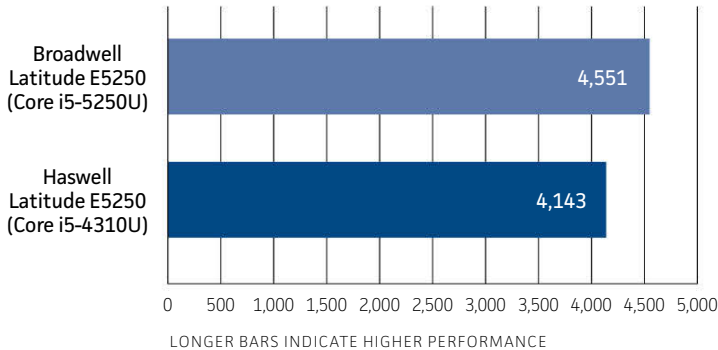
This test gives us two really useful data points. The first is how well a particular CPU performs in this heavily multi-threaded test. Short of an 18-core CPU with 1080p resolution files, it'll max out all cores.

The second data point you get from this test is how much the design of a laptop suffers from thermal throttling. Modern CPUs are designed to slow down when they get too hot or if the PC maker determines it's heating up the entire laptop too much. For example, if you look at the Handbrake test in my recent review of the Lenovo LaVie Z (go.pcworld.com/lavie), you can see how much certain PC designs will throttle back the CPU's speed—the review's Handbrake chart shows the impact of thermal throttling from the Surface Pro 3



In our Handbrake task, the older Haswell and the newer Broadwell are almost dead even.

3DMARK CLOUDGATE

**Broadwell**

features an improved graphics core over Haswell and that shows up here.

and the Lenovo ThinkPad X1 Carbon, both of which have the same CPU. If you look at the result from the HP Spectre x360 and compare it to the Dell XPS 13 that has the same CPU, you also see the performance drop off to aid and abet the cooling capability of the laptop (or the decision by the laptop maker not to heat it up too much).

With all that said, let's now look at the results from the Broadwell and Haswell units. Both use the exact same cooling system, from what I could tell looking inside both. The Broadwell technically loses here, by less than 1 percent. But when you remember that the Haswell technically has the higher clock speed, it's actually a win for the Broadwell to be so close.

3DMARK GRAPHICS PERFORMANCE

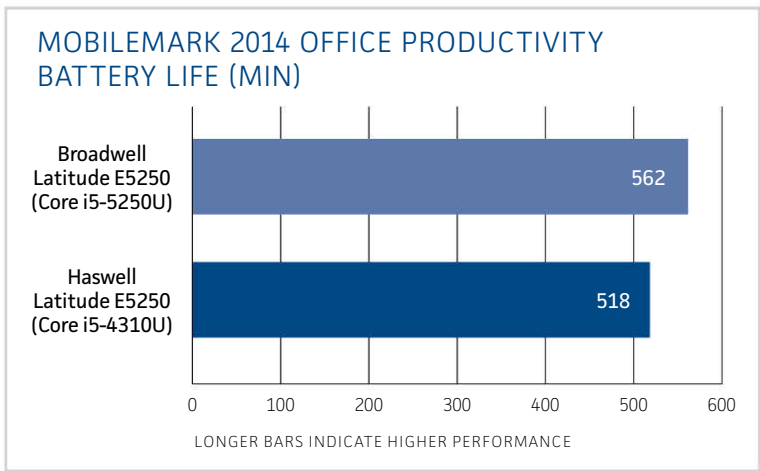
While Intel says Haswell-to-Broadwell performance shows maybe a 5 percent difference on CPU functions, on graphics the company says the spread's more significant. That shows up in 3DMark, where the Broadwell-chipped Dell offers up about 10 percent more graphics performance in Cloudgate. I even saw a 15 percent difference between the two when the graphics load is scaled back further to 3DMark Ice Storm Extreme. Don't fool yourself—you won't be playing

Batman: Arkham Knight at 4K with either CPU, nor any recent graphics-intensive game, but a game of *Minecraft*, *Counter Strike*, or *Portal 2* with the settings turned down enough are playable.

My last benchmark chart for the mobile dual-cores is the most important one for the applications in an ultra-portable laptop. Let's be realistic: People aren't encoding 4K video or playing *Battlefield 4* on these laptops, they're pushing browsers, Office, and maybe Photoshop, or coding on them. All within the performance envelope of a dual-core processor. What people care about most is the battery life.

MobileMark 2014's Office Productivity battery test uses common applications such as Word, Acrobat, and Chrome to simulate a day of pushing mundane office tasks while on a battery. The test even lets the laptop go to sleep for a few minutes, when the typical office drone might be checking their phone or chatting to the person in the next airplane seat.

Here we see the 14nm Broadwell CPU pay off very healthy dividends over the 22nm Haswell CPU. Remember, both laptops use the exact same-capacity battery, SSD, OS, and just about everything else. For the record, the RAM chips were different, as were the battery makers, but they used the same specifications.



Here's the one

that matters: Broadwell is indeed better at battery life than Haswell but probably not enough to make you jump ship.

With all things being equal, a 10 percent improvement in battery life is significant when you consider that Haswell was already an outstanding performer. Haswell significantly moved the ball forward over Intel's 3rd-generation Ivy Bridge CPU. Matt Smith actually did a somewhat similar test (go.pcworld.com/smith), pitting an Ivy Bridge laptop against a Haswell laptop. Both laptops were similar, but Haswell CPUs required a wealth of new components such as chipset and voltage changes, so comparisons don't really isolate just the CPU.


I'm fairly certain that if the laptops used here had CPU sockets and I could switch the chips, my results would be the same.

CONCLUSION

Broadwell cuts both ways. Broadwell is better than Haswell by 5 percent to 10 percent or so on a given task when the CPU models are exactly the same. Battery life is better by 10 percent or so. Graphics performance is much improved, but it's still just integrated graphics, best suited for office droneage or low-ambition gaming.

If you were to buy a laptop today, Broadwell is the way to go—if your options are between a Broadwell-based CPU and a Haswell-based one at the same price.

If you have a Haswell-based laptop, however, there's no point in upgrading to Broadwell. I don't expect that many people who bought a Haswell-based laptop in 2014 are deciding to upgrade to one with a Broadwell CPU a year later just for the CPU. They might upgrade for pen support, a better screen, or a larger SSD or keyboard, however.

This information is really aimed at those using even older, 2nd-generation Sandy Bridge CPUs or 3rd-generation Ivy Bridge CPUs. Moving to a modern Broadwell laptop would deliver significant improvement in battery life and clock-for-clock performance, not to mention all of the other advances in screen quality, touch, and SSD support. For those replacing an older laptop, Broadwell is the better CPU, and our tests prove it. 



Plant a Billion rees

Join The Nature Conservancy to plant a billion trees,
one tree at a time, in the fight to end climate change
at plantabillion.org

The Nature
Conservancy 
Protecting nature. Preserving life.™



5 free Wi-Fi tools that help maximize your home network

BY IAN PAUL

Wi-Fi made more wonderful

Forget about sliced bread—Wi-Fi is easily one of the greatest inventions of the last few decades. Thanks to Wi-Fi every device in your home can easily get online, whether it's your iPad, desktop PC, the high-definition television in the living room, and maybe even your coffee pot or fridge.

But are you getting the most out of your wireless Internet connection? Is it truly as fast as your service provider claims? Are the neighbors screwing up your signal? Do you know how to connect all your various devices together to share files at home?

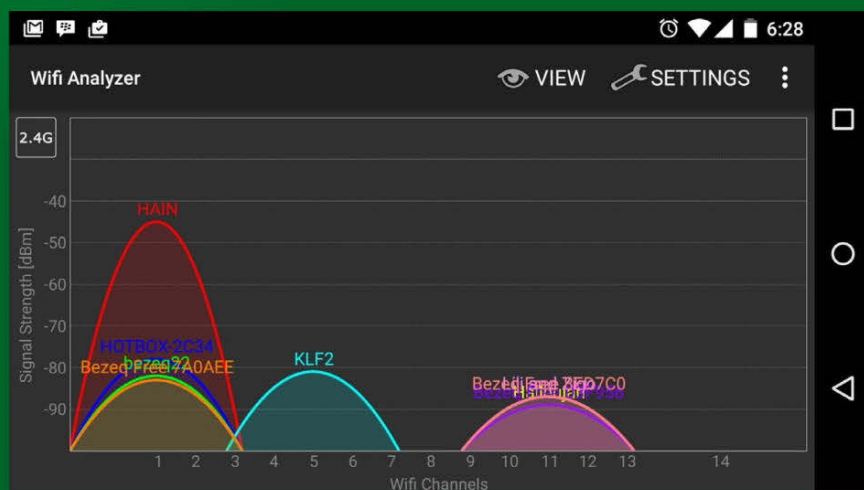
Here are five free Wi-Fi-enhancing tools that can help you answer “yes” to all of those questions.

1.

Channel changers

Sometimes getting a better Wi-Fi signal is as simple as changing the channel. If you live in a densely populated area such as an apartment or townhouse complex, you are probably surrounded by dozens or even hundreds of individual Wi-Fi routers. Each one is broadcasting a signal to help its owner get online. The problem is that sometimes a bunch of closely situated routers can end up interfering with each other.

When that happens you can help yourself out by changing your router's broadcast channel. To help you find an ideal channel (read: the least populated) use ViStumbler (vistumbler.net) on Windows to get all kinds of data on the Wi-Fi routers around you. Or you could give Wifi Analyzer (go.pcworld.com/wifianalyzer) for Android a try—this is also a great option to test signal strength at different points in your house.

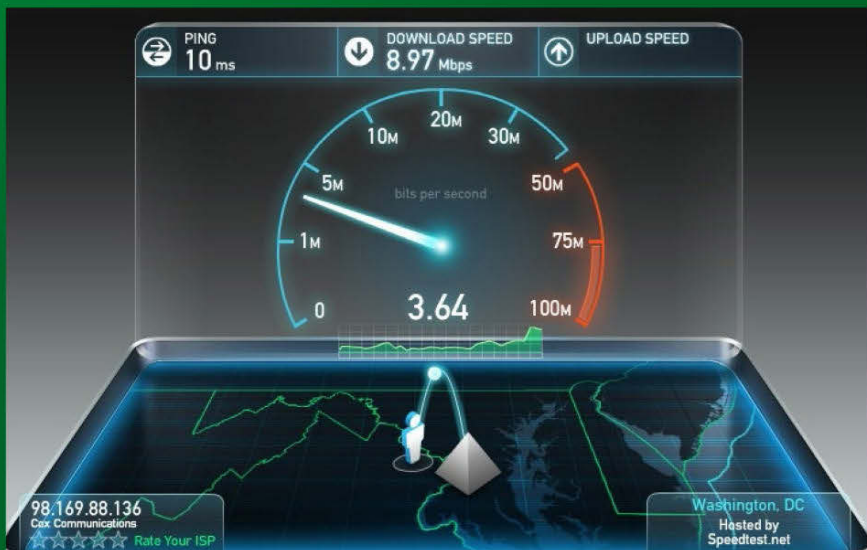


2.

Speed test

The golden rule of Wi-Fi service is to never believe the speed promises your Internet Service Provider makes, at least not without checking. That's where Ookla's Speedtest.net ([speedtest.net](https://www.speedtest.net)) comes in. This simple service quickly checks your network speeds in an easy to understand format that highlights your download and upload speeds.

There are also mobile apps for Android, iOS, and Windows Phone, which is handy when you want to quickly check out your hotel Wi-Fi speeds, or even what kind of speeds you can get in the attic.



3.

Transform your PC into a hotspot

It's easy to let your phone or tablet become a Wi-Fi hotspot that other devices can connect to, since most modern mobile operating systems come with a one-click solution to make this happen. Your laptop or desktop PC, however, does

not. There are built-in methods for various builds of Windows, but they are either a little complicated or involve jumping onto the command line. (Ugh.)

To get around this there are many third-party apps you can download to make your PC a

hotspot, including

Connectify

(connectify.me),

MyPublicWiFi

(mypublicwifi.com),

and Virtual Router

([virtualrouter.](http://virtualrouter.codeplex.com)

codeplex.com).



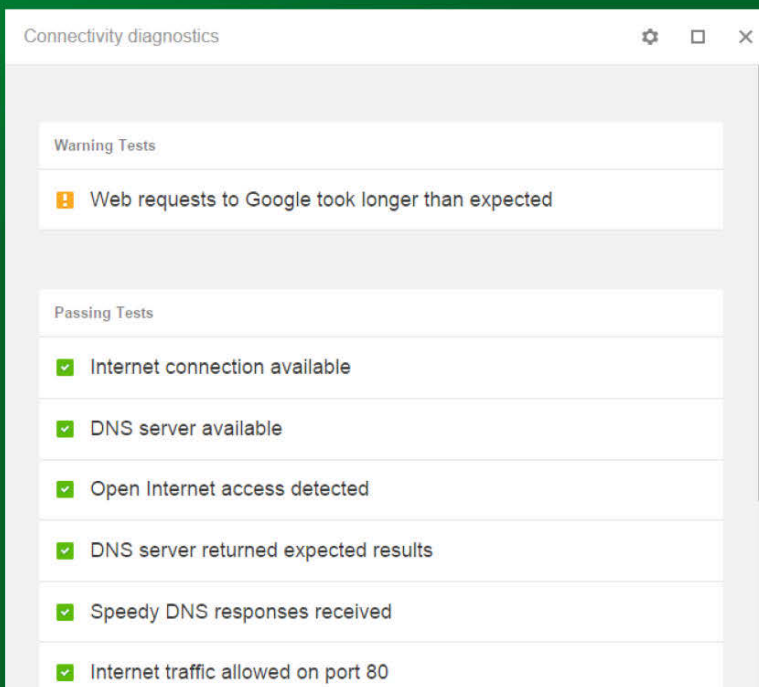
4.

Chrome Connectivity Diagnostics

So you've tried changing channels, but you're still having issues with your Wi-Fi. Google has a Chrome app that can help called Chrome Connectivity Diagnostics (go.pcworld.com/chromeconnectdiag). This app runs a number of tests

on your laptop's current Wi-Fi connection to determine whether you have an Internet connection available to you, a DNS connection, and the right ports open on your laptop, and then it runs a bunch of checks with Google products.

If there are any issues you'll see them at the top of your window under a heading called Warning Tests. As you can see, my network was having issues one day with a slow connection. Click the problem and you get a summary of what's going on. There are also some Chrome OS-only features including Wi-Fi network strength and whether your default gateway is reachable.



5.

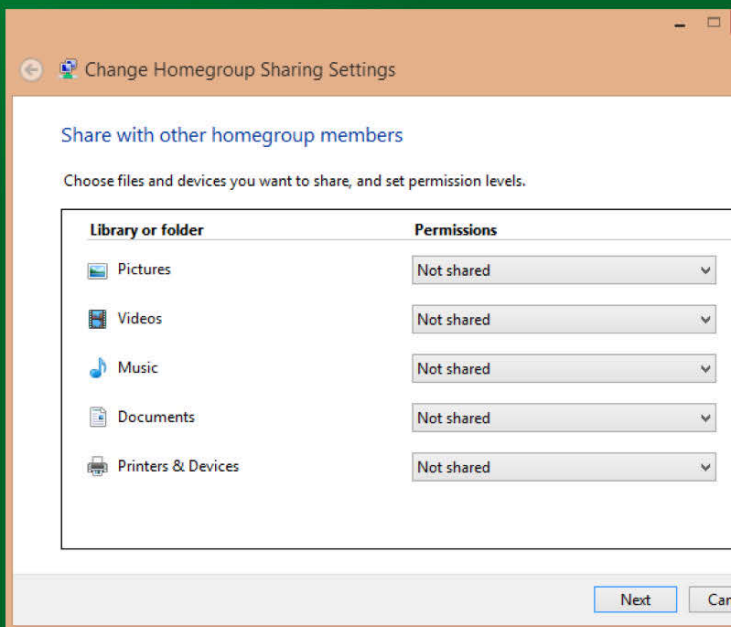
Transfer files

Part of the beauty of Wi-Fi is that you have a variety of devices all over the house and they are all connected to the same network. Getting those devices to talk to each other, however, is not so simple—unless you know about the right

software to use.

The simplest option for PCs is just to use the Windows HomeGroup (go.pcworld.com/win7homegroup) feature first introduced in Windows 7. This will let you share printers, music, videos, and documents. For mobile devices, tools like AirDroid (go.pcworld.com/airdroidmirroring), Pushbullet (go.pcworld.com/pushbulletportal), and Dooblou WiFi File Explorer (go.pcworld.com/dooblouwifi) can help move data to a PC. Finally, if you want to keep a folder or set of folders in sync, then your best option is BitTorrent Sync (go.pcworld.com/bittorrentsync).

Some of these tools don't necessarily require you to be on the same network, but things tend to go faster when they are.





News, tips, and reviews covering phones, tablets, apps, and all the other tech in your life.



TechHive helps you find your tech sweet spot.

We steer you to products you'll love and show you how to get the most out of them.

www.techhive.com | Follow us





**“ SURE,
AT FIRST I WAS A LITTLE TAKEN ABACK
BY THE WHOLE PEEING STANDING UP THING.
BUT I TAUGHT HIM TO THROW A STICK
AND NOW HANGING OUT WITH HIM
IS THE BEST PART OF MY DAY.”**

**— EINSTEIN
adopted 12-09-10**

**A PERSON
IS THE BEST
THING TO HAPPEN
TO A SHELTER PET**



adopt

theshelterpetproject.org



HERE'S HOW

CONTENTS

- | | | | |
|-----|---|-----|---|
| 144 | 4 Gmail Labs features you should be using | 160 | Hassle-Free PC
Turn multi-page web articles into a single, scrolling page |
| 148 | Excel's best tricks: How to make a calendar | 162 | Answer Line
5 ways to add SSD speed to your laptop without losing storage capacity |
| 156 | The 3 step plan to make your website hard to hack | | |

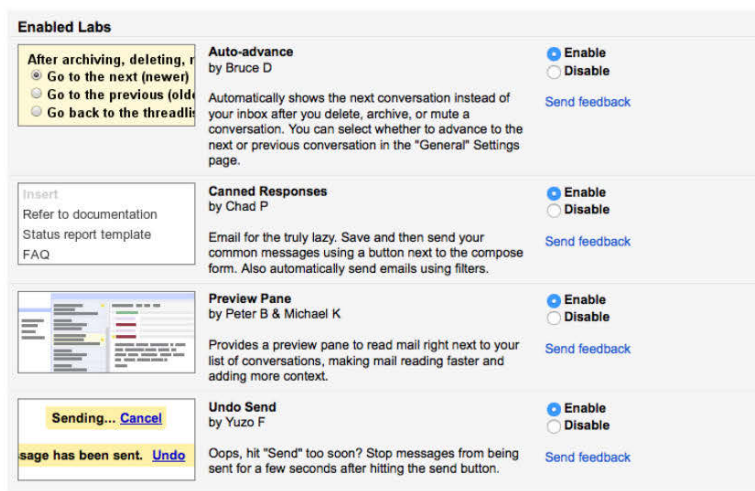
4 Gmail Labs features you should be using

Make your Gmail inbox more productive with experimental add-ons like Undo Send, Canned Responses, and more.

BY MICHAEL ANSALDO



Gmail Labs calls its features “some crazy experimental stuff.”



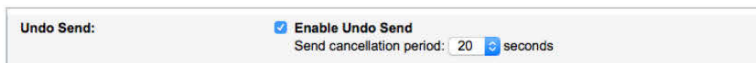
AS POWERFUL AS Gmail is, you can make it even more productive with add-ons from Gmail Labs. If you're new to Labs, it's the testing ground for Gmail's more experimental features. The successful ones go on to become standard Gmail capabilities—the much-loved Send & Archive button was once a Gmail Lab experiment—but while they're in the Labs, there's always the outside chance they could break, change, or disappear.

To enable any Gmail Lab feature, click the gear icon in the top left of the Gmail pane. Go to Settings → Labs. Scroll down to the feature you want, select the Enable radio button, and click Save Changes. Should you run into trouble using any of these, you can get to your email by going to <https://mail.google.com/mail/u/0/?labs=0>, which disables these features so you can reach your inbox.

Assuming you're comfortable being Gmail's guinea pig, here are four Google Labs features you should experiment with yourself.

Undo Send

Whether it was a simple snarky remark or a seething message, we've



Once you enable Undo Send, configure your cancellation period on the General Settings tab.

all felt the pang of regret after sending an email we probably shouldn't have. If you just can't control your impulses, Gmail's Undo Send feature can save you from having to eat a heaping helping of humble pie.

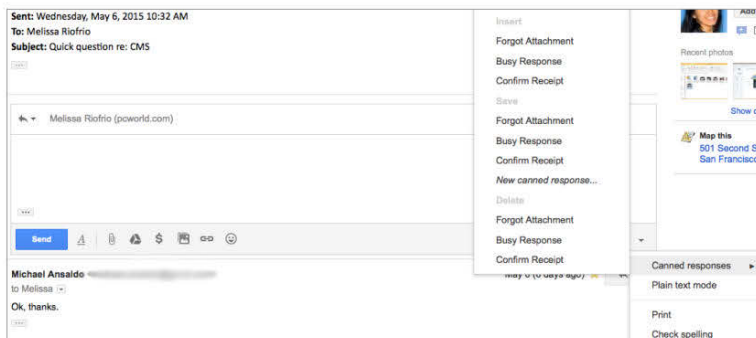
This feature will delay sending your email messages 5, 10, 20, or 30 seconds, giving you a grace period during which you can hit an Undo button and prevent your missive from going out. Once you've enabled it, just set your Cancellation Period on the General tab under Settings.

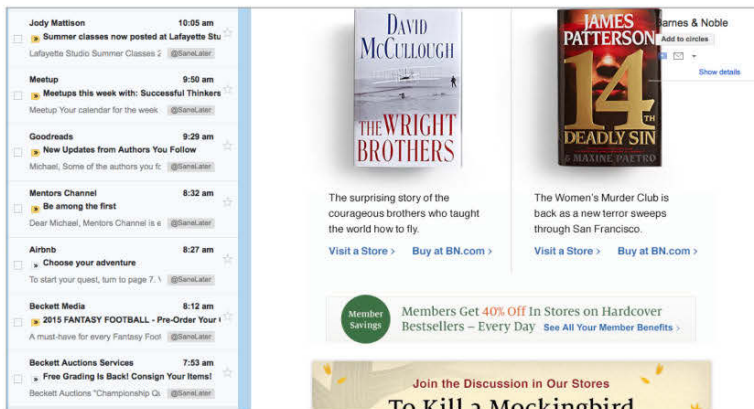
Canned Responses

We all have certain email replies that we send over and over—"busy" responses, receipt confirmations, and away messages, for example. Google Labs Canned Responses lets you pre-write and save these evergreen messages so you can send them with one click.

Once you've enabled this feature, creating a canned response is simple. From your inbox, click Compose, and type a reply you want to save. Next, click the arrow in the lower right corner of the message window and select Canned Responses ➔ New Canned Response. Name the response, and click OK. When you want to use a canned response, click the arrow again from the message you're replying to, and select Canned Response, then the name of the one you want to insert.

Canned Responses lets you insert common replies with one click.





Preview Pane


lets you view messages as you browse your inbox.

Preview Pane

One downside to Gmail is you have to open a message to see its contents, which is a time suck when you're trying to browse through your inbox. Preview Pane gives Gmail's web interface the multipane view we've become accustomed to on most desktop email clients, and let's you view messages as you scroll through them.

When you enable this feature, a new button will appear next to the gear icon in your inbox. From here you can toggle Preview Pane on and off and select either a vertical or horizontal orientation.

Auto-advance

If you're processing your emails in bulk at designated times rather than as they arrive—as you should be—you know it's a drag to have to return to your inbox after handling each message to select the next one. Auto-advance saves you time by automatically moving to the next oldest message (if you process your inbox from the top down) or next newest (if you process from bottom up). You can configure your preference on the General tab under Settings. 



Excel's best tricks: How to make a calendar

BY JD SARTAIN

SO, WHAT ELSE can Excel do? People ask this question all the time. The answer is “almost anything.” Excel has evolved into one of the most versatile programs available. In addition to spreadsheets that calculate everything, it's also a database, a programming tool, a graphics program with charts, tables, drawing tools, photos, clipart, and even layout abilities, and it's a limited, but functioning, word processor (with a spell checker, Thesaurus, grammar tools, research capabilities, translation

functions, and more).

With its graphic features, you can create anything from a detailed drawing to an edited photo. You can make calendars, note pads, list pads, schedules, grid/graph paper, greeting cards, business cards, etc. If you're wondering why anyone would use Excel over programs such as Photoshop and/or Illustrator, the answer is simple. Not everyone has access to graphics and/or photo-editing software. And, although Windows includes PC Paint as an Accessory program, it's actually easier—in many cases—to use Excel for some projects. .

With Excel's graphic features, you can create anything from a detailed drawing to an edited photo.

How to start your calendar

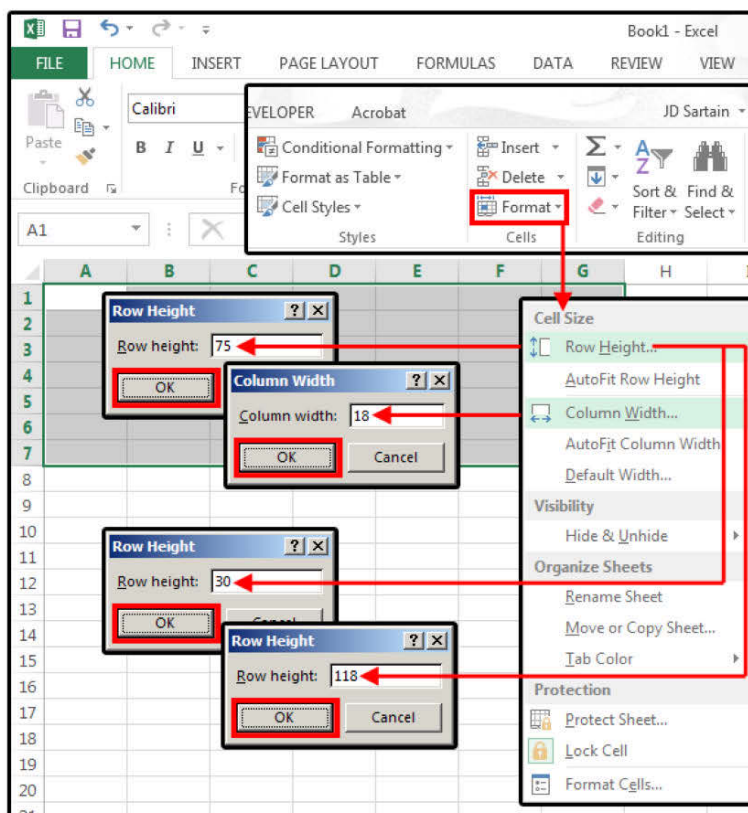
Open a blank worksheet. Highlight Columns A through G, then roll your cursor down to extend the highlight through Row 7, making the range A1 through G7. From the Home tab, select the Cells group, and click Format → Column Width. Type 18 in the Column Width dialog box, then click OK. With the range still highlighted, select the Cells group, and click Format → Row Height. Type 75 in the Row Height dialog box, and click OK. Move your cursor to the Home position, A1. Change the Row Height to 118. Cursor down to A2 and change the Row Height to 30.

Highlight the range A1 through G7 again. Select the Page Layout tab, choose Orientation from the Page Setup group, and click Landscape. Next, click Margins from the same tab and group, and select Custom Margins from the list. The Margins tab in the Page Setup window appears. Press the Tab key once, and your cursor moves to the first setting: Top.

TIP: It's so much easier and faster to just tab and type through these settings, rather than trying to highlight each field box and cursor the up/down arrows.

In the Top field box, type .25, then press the Tab key and your cursor moves to Bottom. Enter .25, press the Tab key, cursor moves to the

1. Select range,
adjust column
and row size.



Left field box. Enter .25, Tab to the Right field box, enter .25. Press the Tab key, cursor moves up to Header, enter 0. Then tab again down to Footer, and enter 0. Press Tab again, and the cursor moves to the Center on Page panel. Check both Horizontally and Vertically, then click OK.

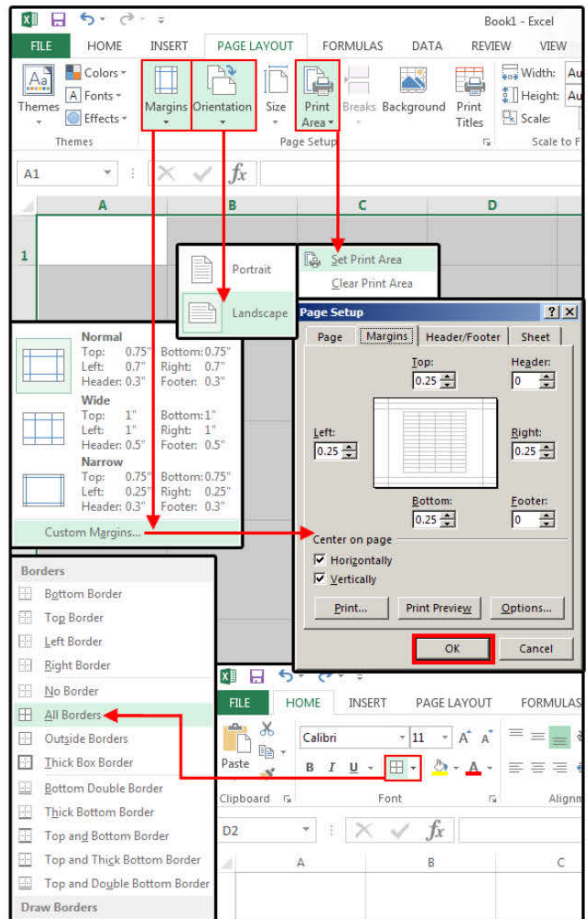
With the area still highlighted, click Print Area → Set Print Area from the same tab and group. It looks like nothing happened, but press the Home key once, and notice the solid (or dotted) line around the area you just selected. This is the area of your spreadsheet that Excel prints, as long as you don't change the Print Area to something else.

Highlight a new area: A2 through G7. Click the Borders button in the Font group, under the Home tab, then choose All Borders from the drop-down list.

Enter the days of the week in Row 2 (A2:G2), center horizontally and vertically, then enter the days of the current month on the calendar. Next, merge the top cells into one. Highlight Row A1 through G1, then select Merge & Center from the Merge button under the Home tab, Alignment group. Now, let's add a fancy title (June 2015). Click Insert → Text → WordArt and choose a style for your text, then type June 2015 in the field box.

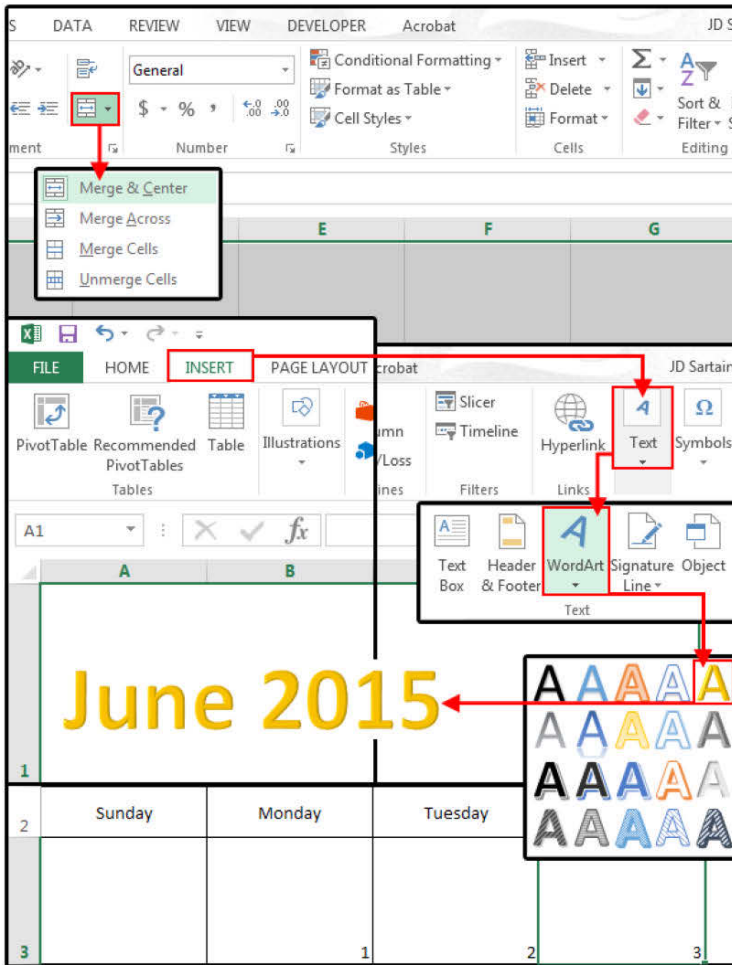
If you'd prefer a more ornate month and year, try some clipart. Delete the WordArt, then select Insert → Illustrations → Online Pictures, and type June in the search box. Choose an image for the title, then size to fit. Next, add some clipart images to decorate your calendar. Select Insert → Illustrations → Online Pictures again, type Summer in the search box, then choose from the filtered selection. Size to fit in the space provided. Note: Sizing down is usually no problem, but enlarging (or sizing up) will likely result in a blurred image.

If you happen to select an image with unwanted areas, such as a



2. Page Setup
and Borders for
your calendar.

3. Merge cells and insert WordArt.



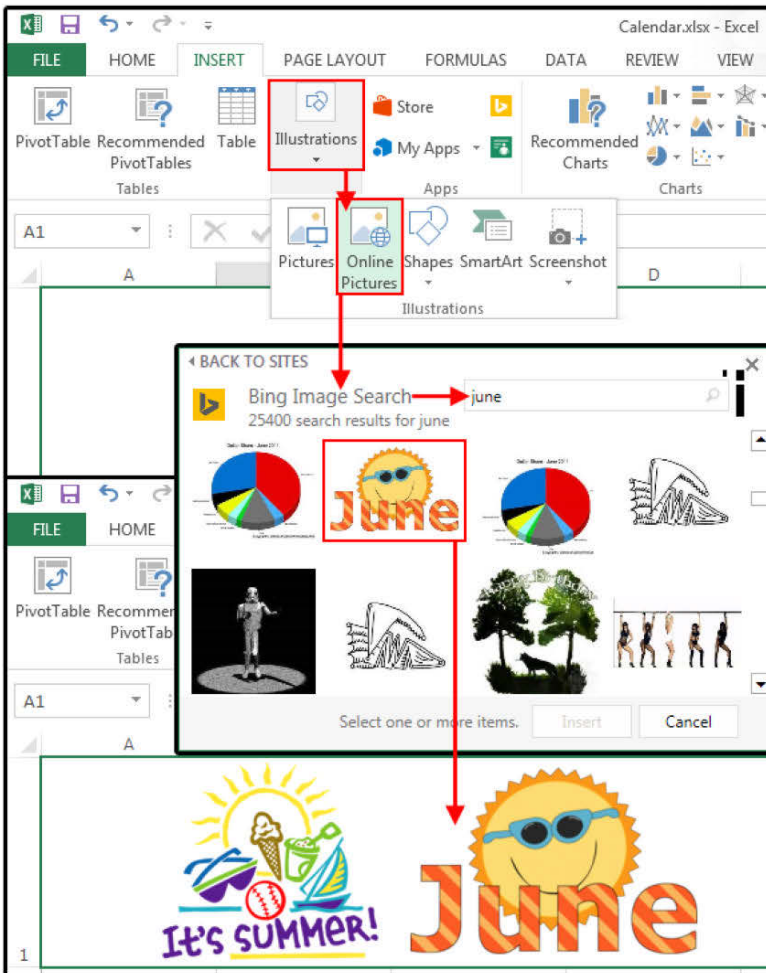
picture with the wrong year, you can crop the image to remove that element, but only if it's standing alone beside a border. First, the image must be selected so the Picture Tools/Format menus are displayed. Select Format → Crop → Crop. Notice the black “handles” around the image. Put your mouse cursor on one of the handles, hold down the left mouse button, and then slide the handle up, down, or

over to crop out the unwanted sections. When satisfied, click anywhere outside the image borders and the image is cropped.

Next, size and place. But the background is blue, and you want a transparent background. No problem. Select the image, (the Picture Tools/Format menus appear). Choose Format → Remove Background → Mark Areas to Keep. Use the handles on the image to adjust the

4. Use

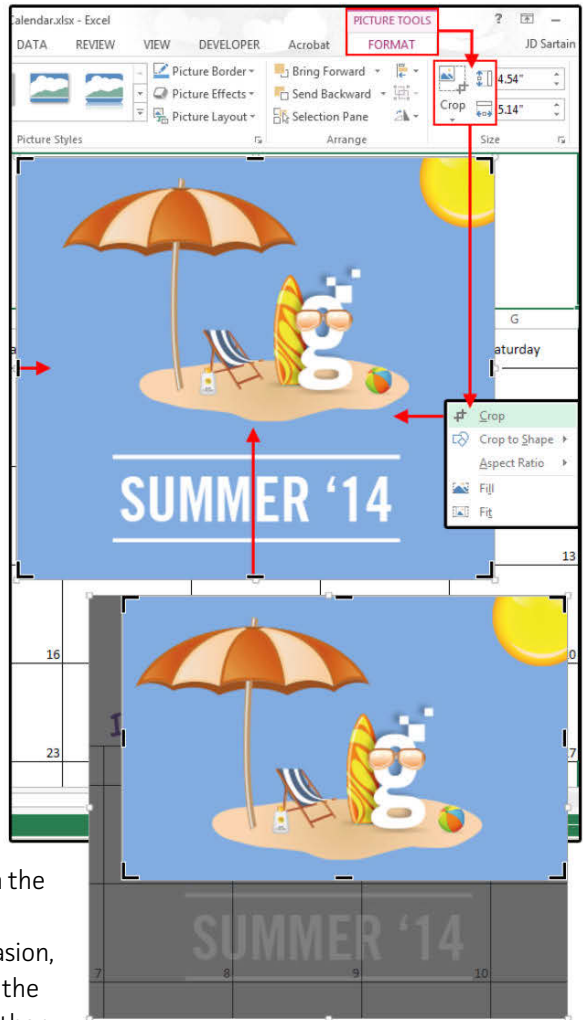
WordArt or clipart to enter the month and decorate the calendar.



border around the parts of the picture you want to keep. Since you've already cropped it, just stretch the borders towards the center, then click outside the image area and it's done. The background is transparent, the wrong year is cropped out, and it's sized to fit in the header space above your calendar.


Last, add holidays and any special occasion days such as birthdays, graduation, or anniversaries. To add text to a date, position your cursor on the target date; for example, June 12th. Press the function key F2 to edit this cell. The cursor positions to the right of the number 12. Because the numbers are on the bottom-right corner—unless you want to change that—press the Home key to reposition the cursor before the day.

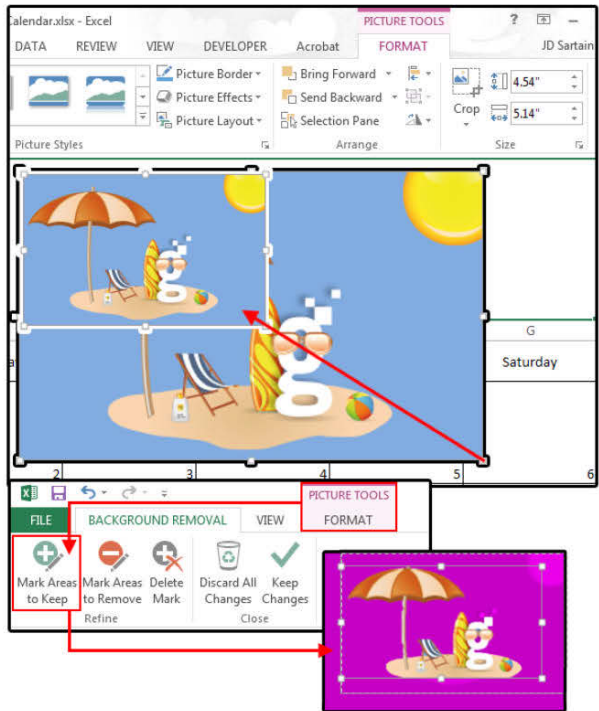
Now type the name of the occasion, then press Alt+Enter (hold down the Alt key, then press the Enter key, then release both keys), once for each additional line added—in this case, once to separate the text from the number, then three more times to move the text to the top of the calendar box. Now the data is on the right. No problem, just click the Align Right button on the Home tab,



5. Crop unwanted parts out of the images.

Alignment group and the data moves to the right.

Note: You cannot right-justify the number, then center or left-justify the text, because Excel doesn't allow multiple paragraph styles in the same cell. You can click the Increase Indent button (also in the Alignment group) to move the data two pixels away from the right border. But you can use multiple font attributes such as Bold for the number and Italics or a different color for the text. Press F2 to edit, then highlight the number or the text and choose a new color or attribute. If you want both the same, then just position your cursor on that cell and choose an attribute and color. 



6. Size, place,
and remove the
image
background.

  June  IT'S SUMMER!					
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
		1	2	3	4
					Mom's birthday
		8	9	10	11
Flag Day					12
		15	16	17	18
Father's Day					19
		22	23	24	25
		28	29	30	

7. Add special occasion days. Note: the image is cropped to fit this page. The original is a complete seven-day calendar.



The 3-step plan to make your website hard to hack

Online attackers are increasingly targeting websites. Protecting your online brand requires vigilance.

BY ROBERT LEMOS

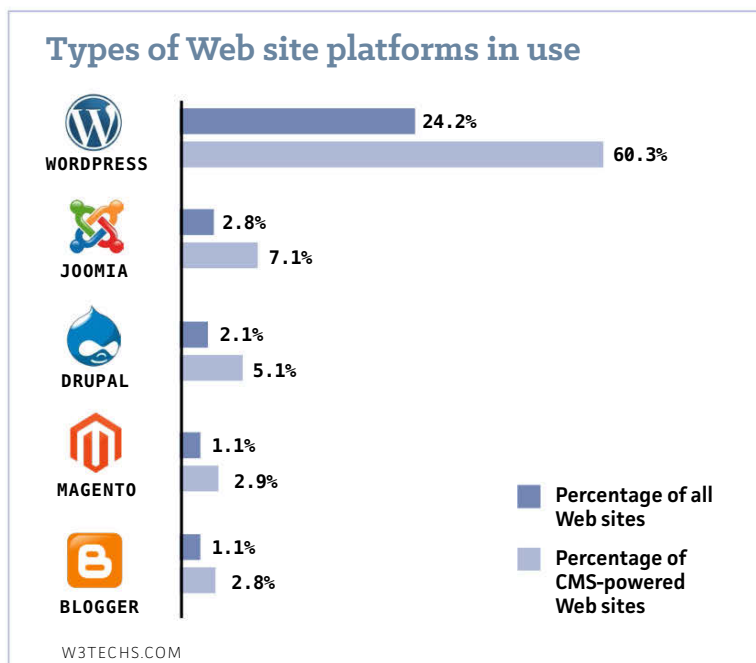
WHEN A BIG website like Lenovo's gets hacked, it's news. But most such attacks take place under the radar, at smaller sites lacking the skills or time to protect themselves. Take the legions of WordPress-based sites, which got a rude awakening last year when many thousands (go.pcworld.com/thousands) of them were hacked.

Don't be one of those sites. Even if you don't use WordPress, you can learn important lessons from what those poor blighters have been through.

The un-magic bullet: site maintenance

Quickly spinning up a WordPress site on a hosted server is simpler than ever, but users need to understand that the sites require regular management. Cybercriminals and hackers are continuously looking for sites whose administrators use easy-to-guess passwords, inadvertently misconfigure the site, or fail to apply the latest patch.

Earlier this year, for example, security firm Zscaler found that compromised WordPress websites were forwarding visitors' login credentials (go.pcworld.com/zscaler) to an attacker-controlled site. Last year, in one of the worst cases of serial compromise, a malicious program, known as SoakSoak, infected (go.pcworld.com/infected)



WordPress accounts for about a quarter of all websites and 60 percent of all CMS-powered websites.

more than 100,000 WordPress sites using a vulnerability in a popular plugin. “The beautiful thing about these applications is that they are easy to use and make it easy to get a website up online,” Tony Perez, CEO of Sucuri, says. “But it’s a double-edged sword—we cannot depend on the users to be able to manage the sites securely.”

Security experts don’t blame the content management systems, which typically take security seriously. But WordPress sites account for 24 percent of all websites, and Joomla and Drupal account for another 5 percent, according to Web technology firm W3Techs. The software is under intense attacker scrutiny. Attackers have historically tried brute-force password guessing as a first assault on content management systems, followed by quickly attempting to take advantage of any just-published vulnerabilities.

Security experts don’t blame the content management systems, which typically take security seriously.

Passwords are an easy problem for users to solve, but keeping up with a steady stream of vulnerabilities and patches requires diligence, says Mark Maunder, CEO of WordPress security firm Wordfence. These three best practices will help you fend off attackers.

1. Update as soon as possible

Anyone managing their own site should either use a hosting service that manages the core content management system (CMS) updates or create a process to keep up with information on vulnerabilities that could impact their installation.

Be warned, it’s a tough job. Subscribing to any vulnerability feeds for their software and plugins is a necessity to quickly patch vulnerabilities in either the CMS or its plugins. Yet, it’s easy to be inundated, says Sucuri’s Perez.

“It is almost impossible for developers to keep up with vulnerabilities,” he says. “They are trying to run their site, and trying to keep track of all the patches and applying them is difficult.”

Web-security services like Sucuri, Cloudflare and Incapsula can buy

administrators more time to patch their sites, by blocking known attacks.

2. Don't forget your plugins and themes


While keeping the main content management system up-to-date is challenging, patching every plugin can be a more onerous burden, as attackers have increasingly targeted vulnerabilities in plugins and themes to compromise websites.

"In general, attackers are trying to own as many WordPress sites as possible using as many zero days or recently-disclosed vulnerabilities, and then using that site for other attacks," says Wordfence's Maunders.

A variety of WordPress plugins provide security. Wordfence, BulletProof Security and iThemes Security perform a variety of security-related tasks, from scanning websites for compromises to setting the security controls of a WordPress site to harden the software against the most common attacks.

3. Regularly maintain your website

Having a hosted website is a responsibility and requires frequent maintenance. Administrators should back up the site, and make sure the backup is copied off the Web server—many inexperienced administrators overlook that step, says Maunders.

If you don't have time to do this, go with a fully managed site. WordPress.com has a wide variety of templates and more flexibility than ever before. For other content management systems, such as Joomla and Drupal, a hosted service provider can manage the CMS on that server and help keep your website patched. 



Turn multipage web articles into a single, scrolling page with this extension

Autopagerize is an add-on for Chrome and Firefox that automatically loads the next page as you scroll.

THIS ONE'S FOR the anti-clickers. Despite fast Internet connections and zippy PCs, web designers still like to organize really long content into multiple pages. That can be for financial reasons (more clicks equals more ads thus more revenue) or just because the designer thinks it's more

manageable for the reader. Visual content in particular suits itself well to slideshows.

But the downside for the user is you have to constantly click through to the next page, whether it's a Google search, or a lengthy news article. All that clicking can interrupt your concentration.

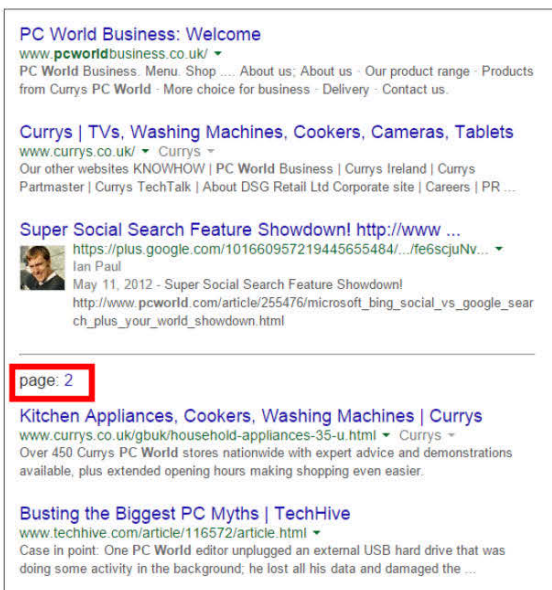
There are a whole bunch of add-ons that try to solve this problem. To save you a few clicks they automatically load multi-page content while you scroll. I've been trying out a bunch of these add-ons. Some work really well, some don't work at all, and some seemed a little sketchy.

I've settled on one that I think you should try out: Autopagerize (autopagerize.net). This add-on is available for both Chrome (go.pcworld.com/autopagerizechrome) and Firefox (go.pcworld.com/autopagerizeffx) and works very well on many major sites.

Unfortunately, it doesn't work on *PCWorld*, but it will work on more general sites like Amazon and Google. The add-on is pretty simple. You just install it and it starts doing its thing. If it works with a site you'll find out pretty quickly. Just sit where you'd normally click to the next page, wait a few seconds, and if the next page shows up then you're good to go.


The downside to this add-on—and this appears to be a trend for this category of app—is that it hasn't been updated in a while. The most recent versions of Autopagerize are from late 2014. So don't expect rapid improvements to the number of sites this extension works with or a full set of customization options.

Still, it's an add-on worth having for those sites it was designed for. 🔌



PC World Business: Welcome
www.pcworldbusiness.co.uk/ ▾
PC World Business · Menu · Shop · About us · Our product range · Products from Currys PC World · More choice for business · Delivery · Contact us

Currys | TVs, Washing Machines, Cookers, Cameras, Tablets
www.currys.co.uk/ ▾ Currys ▾
Our other websites KNOWHOW | PC World Business | Currys Ireland | Currys Partmaster | Currys TechTalk | About DSG Retail Ltd Corporate site | Careers | PR ...

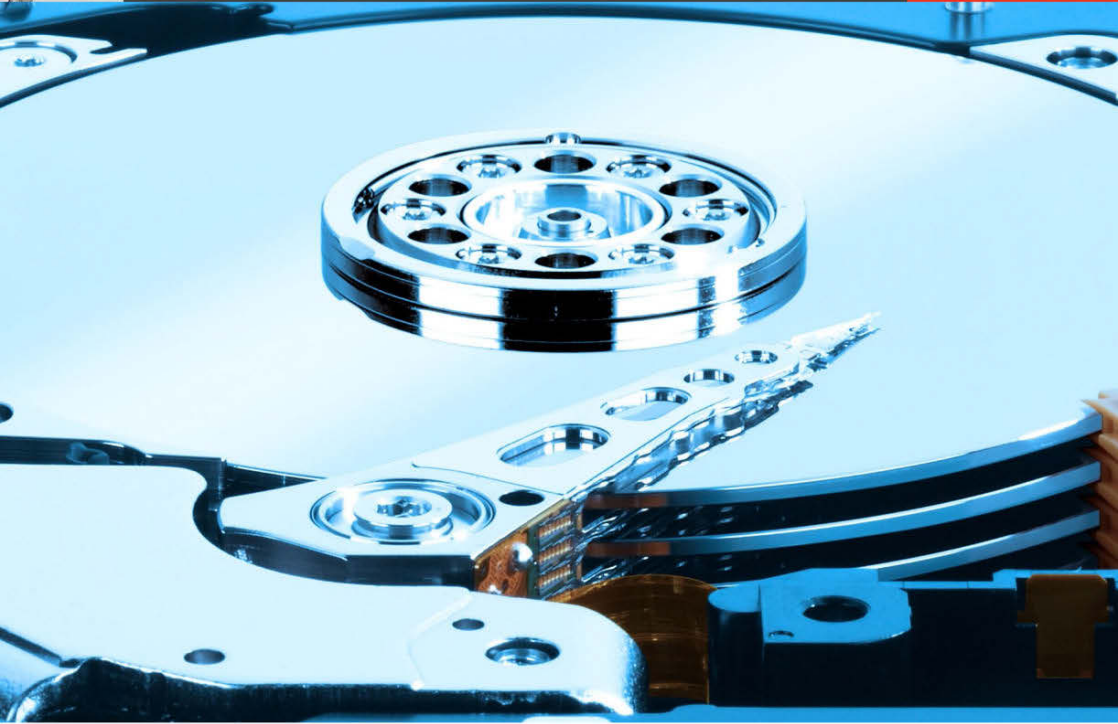
Super Social Search Feature Showdown! [http://www ...](http://www...)
 <https://plus.google.com/101660957219445655484/.../fe6scjuNv...> ▾
Ian Paul
May 11, 2012 · Super Social Search Feature Showdown!
http://www.pcworld.com/article/255476/microsoft_bing_social_vs_google_search_plus_your_world_showdown.html

page: 2

Kitchen Appliances, Cookers, Washing Machines | Currys
www.currys.co.uk/gbuk/household-appliances-35-u.html ▾ Currys ▾
Over 450 Currys PC World stores nationwide with expert advice and demonstrations available, plus extended opening hours making shopping even easier.

Busting the Biggest PC Myths | TechHive
www.techhive.com/article/116572/article.html ▾
Case in point: One PC World editor unplugged an external USB hard drive that was doing some activity in the background; he lost all his data and damaged the ...

Autopagerize
saves you a
click on major
sites like
Google.



5 ways to add SSD speed to your laptop without losing storage capacity

Using an SSD and a hard drive together offers both speed and storage space. But most laptops won't let you install two drives.

ANAND PRABHU ASKED *if there's a way to put an SSD and a hard drive into the same laptop.*

A flash RAM-based SSD gives your PC amazing speed, but it's expensive by the gigabyte. An old-fashioned, spinning-platter hard drive gives you vast amounts of storage for very little money. But if

you use both, and set them up (go.pcworld.com/setup1) intelligently, you can enjoy a hard drive's mass storage without losing too much performance. But that only works if you can install two drives into your PC. That's usually an option only in larger laptops. Some laptops, even affordable ones, support the standard 2.5-inch hard drive/SSD and also have the options to support the flash-only mSATA or M.2 drives. The PC makers then fill the bays depending on what you buy. This still leaves the option for you to populate the mSATA and run the hard drive, too. But let's assume you probably have the typical laptop that only has a single drive bay supporting one hard drive. Here are five solutions:

1. A two-in-one hybrid drive

Devices like Western Digital's WD Black² (go.pcworld.com/wdblack2) put two drives—an SSD and a hard drive—into one container with one SATA connector. For instance, the Black² has a 120GB SSD and 1TB HDD. Thus, you can have speed and mass storage together.

But these hybrids have their problems. They're difficult to install, and often require special software for setup. And you can't just clone your hard drive to the hybrid; you must move Windows to one drive and most of your data to the other. That can be tricky (go.pcworld.com/tricky). Worse, these drives tend to be 9.5mm thick, which means they don't fit in all laptops.



2. A cached hybrid drive

Like the two-in-one, these drives mix both technologies, but in a very different way. Drives like those in Seagate's SSHD (go.pcworld.com/seagatedrive) line use flash RAM as a cache to speed up the hard drive. Because they're seen by the PC and by Windows as a single drive, you can simply clone the old drive to the new one.

They come in all thicknesses. You'll almost certainly find one that fits in your drive bay.

On the other hand, they're not as fast as a two-in-one hybrid.

3: An internal SSD and an external hard drive

This is the cheapest and easiest solution, but it's also the slowest and rather unwieldy. Install an SSD into your laptop, put Windows, your programs, and your frequently-used data files there.

Then put everything else on an external hard drive.

Don't even consider this unless your laptop has a USB 3.0 port, and make sure you have a USB 3.0 drive, as well. USB 2.0 is painfully slow for this sort of work.


And remember to use a different external drive for backup (go.pcworld.com/different).

4: Network-Attached Storage

You can buy a Network-Attached Storage (NAS) device, install one or more hard drives inside, and connect it to your router. Thus you can access your files over your network. Most modern NAS systems also provide a private cloud, so you can access your data over the Internet, as well.

An NAS will probably be faster and more convenient than an external drive—once it's working properly. But it will almost certainly be more expensive and more difficult to set up and if you work remotely, access to files will be problematic.

5: Buy a large SSD

Yes, they're expensive—about \$300 for 960GB as I write this. But this is the fastest and simplest solution. 

Have a tech question? Ask PCWorld Contributing Editor Lincoln Spector. Send your query to answer@pcworld.com



Tech Spotlight

A video showcase of
the latest trends



Watch the
video at
[go.pcworld
.com/
3Dhandvid](http://go.pcworld.com/3Dhandvid)



Exiii Hackberry 3D-printed hand: \$200 affordable prosthetic

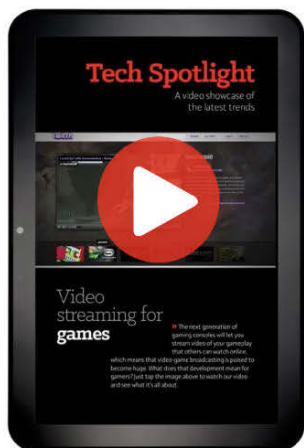
» Unlike high-cost, mass-market prosthetics, 3D-printed hands can be quickly repaired and have custom designs and features such as NFC modules in the fingertips, which could do everything from unlocking smart locks to authenticating mobile payments. Exiii engineers are testing an infrared muscle sensor to control the limb. It's buggy, but it's cheap and simple to set up.

PCWorld enhanced editions

Get your digital PCWorld now!

**The best way to experience
PCWorld magazine on your device.**

The enhanced editions on Android, iPad, and Kindle provide these kinds of interactivity and more!



VIDEOS: Tap and play videos (with Internet connection).



SLIDESHOWS: Swipe image to activate slides.



360-DEGREE VIEWS: See products from all angles.

 Get it here: go.pcworld.com/digital
DIGITAL SUBSCRIPTIONS: Monthly recurring, \$1.99 per month; single issue, \$6.99